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ARDEC ltr dtd 29 Sep 1989

(2)

AD-E401 265

Contractor Report ARLCD-CR-84039

ENGINEERING DEVELOPMENT OF THE XM261 MULTIPURPOSE SUBMUNITION WARHEAD AND THE XM267 SUBMUNITION TRAINING WARHEAD

William S. Marks
BEI Defense Systems Company, Inc.
11312 South Pipeline Road
Euless, Texas 76039

JANUARY 1985

U.S. ARMY ARMAMENT RESEARCH AND DEVELOPMENT CENTER
LARGE CALIBER WEAPON SYSTEM LABORATORY
DOVER, NEW JERSEY

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1. REPORT NUMBER: Contractor Report ARLCD-CR-84039	2. GOVT ACCESSION NO.: AD-B092780L
3. RECIPIENT'S CATALOG NUMBER:	
4. TITLE (and Subtitle): Engineering Development of the XM261 Multipurpose Submunition Warhead and the XM267 Submunition Training Warhead	5. TYPE OF REPORT & PERIOD COVERED: Final Report 79 Sept - 83 Sept
	6. PERFORMING ORG. REPORT NUMBER: BEI FR0314-0253
7. AUTHOR(s): William S. Marks, BEI Defense Systems Company, Inc.	8. CONTRACT OR GRANT NUMBER(s): DAAK10-79-C-0314, DAAK1D-8D-C-0253
9. PERFORMING ORGANIZATION NAME AND ADDRESS: BEI Defense Systems Company, Inc., 11312 South Pipeline Road, Euless, Texas 76039	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS:
11. CONTROLLING OFFICE NAME AND ADDRESS: ARDC, TSD, STINFD DIV [SMCAR-TSS], Dover, NJ D78D1-5DD1	12. REPORT DATE: January 1985
	13. NUMBER OF PAGES:
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office): ARDC, LCWSL, Munitions Systems Div. (SMCAR-LCU), Dover, NJ D78D1-5001	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:

16. DISTRIBUTION STATEMENT (of this Report)

Distribution limited to U.S. Government agencies only, administrative/ operational use; January 1985. Other requests for this document must be referred to ARDC, ATTN: SMCAR-TSS, Dover, New Jersey D7801-5DD1.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

2.75-inch rocket warheads
Submunition Warheads
Armament, Aircraft

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report describes the engineering development program for a multipurpose submunition warhead and a ballistic equivalent training warhead through the type classification and pre-production test phase.

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Unclassified

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INTRODUCTION

The efficiency and effectiveness of submunition payloads compared to unitary conventional ammunition is common knowledge. The application of this technology to aerial rockets was studied and determined feasible in 1974. As a result of that study, an Advanced Development (AD) program was undertaken by ARRADCOM and completed in October 1977. At the Validation IPR, it was recommended that the program proceed into full scale development.

During the AD phase, because of various constraints, the design approach for validating the concept allowed only seven submunitions (SMs) per warhead, and utilized a warhead fuze which functioned upon rocket motor burnout. No warhead cabling was required. This warhead configuration (i.e., with burnout fuze) was designated XM260.

The first phase of Engineering Development (ED) under contract with BEI Electronics Inc. initiated in FY78 was for the development of the XM261, warhead, containing nine submunitions and functioned by the remote settable M439 fuze. This phase provided sufficient warheads and components for preliminary testing, reliability assessment, static mode analysis and initial flight tests. This phase is documented by Reference I.

The project objective is to achieve type classification for standard production of a high explosive multipurpose submunition warhead and a ballistically equivalent training warhead with smoke signature submunitions for the improved 2.75 inch rocket system.

Completion of the Engineering Development program is divided into two phases: Phase II, Completion and validation of the design of the XM261 warhead and design of the XM267 ballistic equivalent training warhead. This phase includes performance testing and evaluation of ability to meet all military standard environmental conditions. Phase III, Production of warheads of the design developed in Phase II for support of DT II Testing, and preparation of the Technical Data Package for the two warheads.

ENGINEERING DEVELOPMENT

Development of the XM261 multipurpose submunition warhead during the engineering design and first engineering development phases was directed toward classification of a high explosive (HE) warhead and utilized inert loaded submunition assemblies with a smoke signature charge to satisfy functional test requirements without jeopardizing personnel safety during evaluation or contaminating the test range with hazardous high explosive dud items.

It was realized that these same concerns would exist in all tactical training exercises which would be conducted with this munition system.

The decision was made to develop and classify a ballistic equivalent training warhead designated XM267 to meet the requirement.

The submunitions for the tactical (HE) warhead are designated "XM73 Grenade" and those for the training warhead are designated "XM75 Grenade". All components with the exception of grenade assemblies are common to the tactical and training warheads.

XM75 Grenade

The XM75 grenade assembly required design of a body assembly which would house a smoke signature capsule and interface with the XM231 fuze in the same manner that the XM73 grenade interfaced with the XM230 fuze. The XM75 grenade had to be a ballistic equivalent to the XM73. The initial design of the XM75 body assembly incorporated an aluminum cone in place of the copper cone used in the XM73, in order to reduce cost in production. All weight and C.G. calculations for the grenade body design were made postulating the aluminum cone and the grenade bodies were procured. The aluminum cones were ordered from the manufacturer who furnished the copper cones to AMRON for the XM73 body assemblies assuming that the same tooling could be used. ARRADCOM engineering expressed concern about die wear in producing the aluminum cones and recommended use of the standard copper cone in the XM75 assembly. This was done and resulted in a slightly heavier grenade assembly and therefore a slight discrepancy between the weights of the XM267 and the XM261 warheads during the engineering development program. The XM75 body design was modified to correct this problem when the DT II quantity was produced.

Smoke Capsule Assembly

The signature charge in the XM75 grenade was developed and used in the validation flight test of the phase I contract. The smoke cup was thermoformed from cellulose acetate sheet and fitted with a lid punched from sheet material. The lid was attached with epoxy cement which did not make a reliable seal. Reliable sealing could be accomplished with a heat sealing machine which would actually make a plastic mold on the lip of the cup. However, commercially available sealing machines were not safety certifyable for pyrotechnics areas. Mylar tape washers with pressure sensitive adhesive on both sides were used to achieve the seal for the and DT II smoke capsules. It is recommended that the capsule be modified for ultrasonic sealing in the production items.

XM73 Grenade

During the initial program planning BEI investigated the requirements in building modification and equipment to do the melt pour HE loading of the M73 grenade assemblies. Building layouts and equipment lists and placement were discussed with the area DCAS safety representatives, and

tentative approval was given to the conceptual designs. The time scale of the development program did not allow implementation of this concept and the HE loading of grenade body assemblies was subcontracted to GOEX Inc. in the Highland Industries Complex. Close engineering contact was maintained during the entire loading program to assure that high quality filling was achieved and to develop cavitation and edge breakout inspection criteria that could be expected to be realized in production. Wind tunnel testing conducted by ARRADCOM engineering demonstrated that full skirted submunitions exhibited excessive (greater than 10 degree total cone angle) coning during descent. The lethality analysis indicated that this phenomenon severely reduced the projected effectiveness of the munition in the antipersonnel mode. The XM73 body design was modified to remove the skirt in alternate 60 degree segments to allow venting during descent. The triangular ram air decelerator (RAD) was located in a fixed position with the points stationed over the skirted segments of the submunition body. This assembly demonstrated acceptable stability during fall. The XM75 body design was similarly modified to match the terminal ballistics of the XM73 grenade.

Fuze Staking

Breed Corporation (Development Company for the XM230 Fuze) designed a staking tool to assemble the XM230 fuzes to inert grenade assemblies during their fuze development program. A copy of their tool was fabricated and used with an air operated press to assemble the fuzes to the grenades for the initial flight test rounds fired during the phase I contract (ref 1). This same assembly process was used for 10 warheads fired at Hawthorne Army Ammunition Plant in May 1980 with satisfactory results. The first two phases of the Engineering Development test program at Yuma Proving Ground were assembled with this equipment. The results of the transportation vibration test are given in reference 2 and indicated multiple failure modes but fuze staking was adequate. The metal parts security and system safety test fired at Yuma Proving Ground 25 and 26 August 1980 showed inadequate fuze staking (ref 3). Fuzes separated from the submunition body in several instances. Analysis indicated the necessity for closer control of both stake depth and concentricity. The staking fixtures were redesigned and the press was changed from pneumatic to hydraulic drive. It was determined that an 800 pound minimum pushout force for the fuze assembly would assure integrity during the ejection process. Inspection procedures requiring push out tests after each 200 staking operations were instituted.

Assembly Procedure

Initial test warheads were assembled with sufficient tolerance washer to assure that the submunition stack was maintained under pressure after nose cone pinning. This was accomplished by pinning while a fixed pressure was held on the nose cone assembly and checking to see that the nose cone flange did not bottom on the forward edge of the warhead case. The transportation vibration and rough handling tests showed pin failure

with this assembly procedure. This failure mode was eliminated by assembling the nose cone base to the warhead under fixed pressure and pinning with two pins. The nose cone base design was modified to assure that it would not project beyond the forward edge of the case under assembly pressure. The nose cone assembly was then attached with the final two pins so that its shoulder was firmly seated on the warhead case.

Development Test II

Development Test II (DT II) (PQT-G) of the MK66 MOD 1 rocket motor and Multipurpose Submunition (MPSM) Warhead was conducted at U.S. Army Yuma Proving Ground (YPG) during the period of March to November 1981.

The dates and tests performed are as follows:

	Test Date	Type
1.	17 and 18 July 1980	Transportation Vibration
2.	25 and 26 Aug 1980	Metal Parts Security & System Safety
3.	19 thru 21 Nov 1980	Transportation Vibration
4.	2 thru 16 Dec 1980	System Reliability
5.	13 thru 21 Jan 1981	Tactical Vibration
6.	13 Jan 1981	System Safety Tests
7.	26 and 27 Jan 1981	Temperature Conditioning Test
8.	3 Feb thru 1 May 1981	Sequential Rough Handling, Waterproofness, Transportation Vibration Tests
9.	June and July 1982	Preproduction Test

Transportation Vibration (No. 1), 17 and 18 July 1980[1]

The transportation vibration test was performed to determine if the XM261 MPSM warhead can withstand expected dynamic vibrational stresses and to determine if performance degradation or malfunctions will result from the transportation-vibration environment.

Four inert XM261 warheads (rounds No. 191 through 194) were assembled to inert MK66 rocket motors, packaged individually in fiber containers and placed in one wooden box.

The box was secured to the vibrator table and exposed to vibration levels and durations in accordance with MIL-STD-810C, method 514.2, equipment category 8, procedure X, table 514.2-VII and figure no. 514.2-7, curve AX.

Upon completion of the transportation-vibration test, the following observations were recorded:

Discrepancies	Round no. 191	192	193	194
1. Felt pad, ARRADCOM drawing No. SK-JM-5 was crushed (fig. 1).	x	x	x	x
2. Metal end cap of cover tube, ARRADCOM drawing No. SK-JM-6 was pushed in (fig. 2).	x	x	x	x
3. No chipboard aft of pad (drawing No. SK-JM-5) as required by drawing by No. SK-JM-6.	x	x	x	x
4. Chipboard forward of pad, ARRADCOM drawing No. SK-JM-5, should be added to prevent the crushing or deforming of pad.	x	x	x	x

1. "First Letter Report of Engineer Design Test of MK66 Rocket/XM261 Submunition Warhead for the 2.75-Inch Rocket (Transportation-Vibration Test)," TECOM Project No. 4-MU-019-261-003, Yuma Proving Ground, Yuma, AZ, 21 October 1980

	Discrepancies	Round no. 191	192	193	194
5.	No spacer on nose cushion assembly, ARRADCOM drawing No. SK-JM-4.	x	x	x	x
6.	Cushion of nose cushion assembly, ARRADCOM drawing No. SK-JM-4, was compressed from 0.07-inch width to 1/2 to 5/8-inch width. Also, the cushion was formed to the inside radius of metal end cap of the outer tube in ARRADCOM drawing No. SK-JM-6 (fig. 3). The cushion compressed approximately 1/4 inch and the 0.37-inch wide spacer was not on the face of the cushion. This permitted the assembled XM261 rocket to move back and forth approximately 1/2 to 5/8 inch within PA67 fiber container.	x	x	x	x
7.	The neck ring signature on the rocket motor case assembly showed that there was longitudinal movement of the assembled XM261 rocket within the M67 fiber container (figs. 4 and 5).	x	x	x	x
8.	Nose cone retaining pins sheared.	3	3	2	3
9.	Nose cone assembly movement after retaining pins were sheared.	1/4 in	1/4 in	1/8 in	Off
10.	Nose cone assembly for round No. 194 was completely separated from warhead assembly (fig. 6 (bottom)).	Sat	Sat	Sat	x
11.	A continuity check of the XM439 fuze showed an open circuit.	x	x	Sat	x
11a.	The copper wire fuze connector cable for XM439 fuze was sheared on the edge of the nose-cone assembly (fig. 7).	x	Sat	Sat	x
11b.	Flex lead of fuze connector cable was cut at the mouth of the warhead case assembly (figs. 8 & 9).	x	Sat	x	Sat
11c.	Fuze connector cable was severed at fuze support, drawing No. 926-0048 (figs. 10 & 11).	x	Sat	x	x

Discrepancies	Round no. 191	192	193	194
11d. Fuze connector cable was partially severed at fuze support, drawing No. 926-0048 (fig. 12).	Sat	x	Sat	Sat
11e. The fuze connector cable was pulled out of connector cable groove of the warhead case assembly, drawing No. 926-0047 (fig. 13).	x	x	x	x
11f. The ground connector was pulled out from XM439 fuze pin connector. A short was indicated on the gage.	Sat	Sat	x	Sat
11g. Fuze support, ARRADCOM drawing No. 0048, was broken.	Sat	x	Sat	Sat
12. No felt tolerance washer	x	x	x	x
13. Ram air decelerator (RAD) unscrews and came off the XM73 submunition fuze nearest to the mouth of the warhead case assembly.	Sat	x	x	Sat
14. The copper cones of the cone and ring assembly, AMRON drawing No. 00022-009, were scored, Each cone was damaged by the rotation of the RAD assembly (fig. 1 (top)).	x	x	x	x
15. After completion of the transportation-vibration test, the sliders for all submunitions were in, the firing pins were extended.	x	x	x	x
16. Firing pin cap stake failed on submunition 193-4 (fig. 14).	Sat	Sat	x	Sat
17. The motor end packing of the wooden ammunition package was crushed during the transportation-vibration test. The packaging was crushed by the loaded PA67 fiber container within the ammunition package (fig. 6 (top)).	Sat	Sat	x	Sat

Metal Parts Security & System Safety (No. 2), 25 and 26 August 1980[2]

The metal parts security and system safety test was performed to determine if the XM261 MPSM warhead could withstand dynamic launch forces, and to determine if performance degradation or malfunctions, particularly critical or catastrophic hazards, would result from the launch environment. Ten inert XM261 warheads with Boeing (plastic) nozzles (rounds no. 1 through 10) were assembled to MK66 Mod 1 motors. Each warhead contained nine inert XM73 submunitions and was assembled with an inert XM230 submunition fuze with a ram air decelerator (RAD), 5.5 grams of propellant expulsion charge and an M439 RC time fuze.

Ten HE XM261 warheads with Naval Ordnance type (steel) nozzles (rounds no. 131 through 140) were assembled to MK66 Mod 1 motors. Each warhead contained nine HE loaded XM73 submunitions and was assembled with an inert XM230 submunition fuze with a RAD, 5.5 grams of propellant expulsion charge and an M439 RC time fuze.

The M439 fuze was set for 1.5 second fuze function time to result in fuze function approximately 0.4 seconds after rocket motor burnout, ejecting the submunitions at a range of 0.8 kilometer for the submunitions to impact approximately 1 kilometer from the firing position.

A summary of the metal parts evaluation is presented in table 8.

One hundred and forty-two individual submunitions were recovered from the impact field after ejection from the warhead. One warhead was found with five submunitions remaining in the case. Of these 142 submunitions, 102 (71.8%) functioned properly. Of the 40 submunitions that unarmed, 4 were found partially armed, and 22 were found unarmed because of separated items.

As indicated in table 8, separation of items from the submunitions occurred at a significant rate. Of the 142 recovered submunitions, 14 instances of RAD separation were recorded, although in two instances, the round had functioned normally. The XM230 fuze had separated in 21 submunitions. A major cause of fuze separations was improper body-to-fuze staking. Of the 24 submunitions recovered with separated RADs, 21 also had separated fuzes.

Because the fuzes were not recovered, it could not be determined if the fuzes were separated in flight or on impact. In the system safety phase, the booster pellet had separated from seven submunitions. The booster pellets that were recovered were not intact, were not found near the recovered submunition, and could not be identified by round number.

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2. "Second Letter Report of Engineer Design Test of MK66 Rocket/XM261 Submunition Warhead for 2.75-Inch Rocket (Metal Parts Security and System Safety Tests)," TECOM Project No. 4-MU-019-261-003, Yuma Proving Ground, Yuma, AZ, 3 December 1980.

Transportation Vibration (No. 4), 19 through 21 November 1980[3]

The transportation vibration test was performed to determine if the packaging for the XM261 MPSM warhead would provide adequate protection to the warhead.

Eight inert XM261 warheads (rounds No. 227 through 234) were assembled to MK66 Mod 1 motors and packaged individually in fiber containers. The inert rounds were placed in two ammunition packing boxes, four inert rounds to each box. One box (rounds No. 227 through 230) was temperature conditioned to -60°F, for all three axes of vibration. The other box (rounds no. 231 through 234) was temperature conditioned to 160°F for all three axes of vibration. The two boxes were exposed to vibration levels and durations in accordance with MIL-STD-810e, method 514.2, equipment category G, procedure V, table VII and figure 514.2-7, curve AW.

Upon completion of the transportation-vibration test, the following observations were recorded:

a. The packing box containing rounds No. 231 through 234 which was temperature conditioned to 160°F was satisfactory. The polyethylene cushion was crushed 1/16 inch when the packing box was vibrated base end down (motor end of packing box). The polyethylene cushion on the nose end of the packing box was satisfactory. The fiber board end, top, and side fillers were satisfactory. Results of round-by-round inspection were as follows:

(1) Round No. 231

(a) Fiber container was satisfactory.

(b) Sealing strips on fiber container were satisfactory.

(c) Nose cone was loose with approximately 1/32 inch wobble.

(d) One shear pin was extended 1/32 inch.

(e) Continuity test check was normal.

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3. "Fourth Letter Report of Engineer Design Test of MK66 Rocket/XM261 Submunition Warhead for the 2.75-Inch Rocket (Transportation-Vibration)," TECOM Project No. 4-MU-019-261-003, Yuma Proving Ground, Yuma, AZ, 17 March 1981.

(2) Round No. 232

(a) Fiber container was satisfactory.

(b) Sealing strips on fiber container were satisfactory.

(c) Nose cone was loose with approximately 1/32 inch wobble.

(d) Nose cone shear pins were satisfactory.

(e) Continuity test check indicated an open circuit.

(3) Round No. 233

(a) Fiber container was satisfactory.

(b) The cover tube and outer tube were separated by 3/8 inch. The warhead was unscrewed from the rocket motor which was a factor that caused the outer tube and cover tube to separate from under the sealing strips. It was noted that the 2-inch sealing strip (PPP-T-60D type W CL 1) was not centered equally over the outer tube and cover tube.

(c) Nose cone was loose with approximately 1/32 inch wobble.

(d) One shear pin was extended 1/32 inch.

(e) Continuity test check was normal.

(4) Round No. 234

(a) Fiber container was satisfactory.

(b) Sealing strips on fiber container were satisfactory.

(c) Nose cone was loose with approximately 1/16 inch wobble.

(d) Nose shear pins were satisfactory.

(e) Continuity test check was normal.

b. The packing box containing rounds No. 227 through 230 which was temperature conditioned to -60°F was satisfactory. The polyethylene cushion and the fiber board end, top, and side fillers were satisfactory. Results of the inspection follow:

Rounds No. 227 through 230

(a) Fiber container was satisfactory.

(b) Sealing strips on fiber container were satisfactory.

(c) Nose cone was loose with approximately 1/32 inch wobble.

(d) Nose shear pins were satisfactory.

(e) Continuity test check was normal.

System Reliability (No. 5), 2 through 16 December 1980[4]

The system reliability test was performed to determine the performance reliability of the XM267 MPSM warhead, including submunition ejection from the warhead case and functioning reliability of the individual submunition.

Sixty XM267 smoke warheads (rounds no. ED71 through ED130) were assembled to MK66 rocket motors and fired with a YPG Rocket Firing Set. The firing was accomplished 20 to 25 seconds after the M439 fuze was charged with a Field Firing Test Set which contains the CM138 Rocket Management Subsystem (RMS) components. This arrangement was permitted for visual monitoring of the fuze charge signature by the field firing test set immediately prior to firing.

The disposition of rounds are as follows:

a. Two rounds (ED110, ED130) were released to the Fire Control Trajectory Test. See reference 1c.

b. Two rounds were not fired because umbilical testing indicated a pre-existing failure. One round (ED116) indicated a short circuit, and one round (ED87) indicated an open circuit.

c. Four warheads (ED76, 100, 115, 119) failed to function after firing.

d. One round (ED126) functioned properly but the submunitions could not be evaluated because none were recovered.

e. Three rounds (ED111, 113, 114) functioned properly but the submunitions could not be evaluated because the function height was too low to permit proper ejection of the submunitions.

f. Forty-eight rounds functioned properly and sufficient submunitions were recovered for evaluation.

The results of all test warheads are contained in the Round-by-round data in table 9, Submunition function data in table 10, Airburst data in table 11, and Submunition impacts in table 12.

From the 48 rounds (432 submunitions) evaluated, 395 submunitions were recovered and evaluated. Forty of the XM75 submunitions failed to function. The point estimate of functioning reliability for each of the three temperature conditions is shown in table 1.

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4. "Fifth Letter Report for Engineer Design Test of MK66 Rocket Motor/XM261 Submunition Warhead for 2.75-Inch Rocket (System Reliability Tests)," TECOM Project No. 4-MU-019-261-003, Yuma Proving Ground, Yuma, AZ, 15 June 1981.

Table 1. Submunition functioning reliability

Temp cond	Functioned	Failed to function	Functioning reliability (%)
155°F	87	18	82.9
-50°F	131	12	91.6
Ambient	137	10	93.2

Submunition impacts of 33 rounds were scored by a television camera in an overhead aircraft. The mean, maximum spread, and standard deviations of the X and Y impacts were calculated on 188 submunitions, and are contained in table 12. Overhead TV scoring of the submunitions generally accounts for 5 to 6 submunition impacts per warhead. The remainder are masked by various factors, principally the fact that two close submunitions appear as one.

Tactical Vibration (No. 6), 3 through 21 January 1981[5]

The tactical vibration test was performed to determine if the 2.75-inch MPSM warhead was constructed to withstand expected dynamic vibrational stresses and to insure that performance degradation or malfunction will not be produced by the operational vibration environment.

XM261 HE Warheads with XM73 Submunitions.

Nineteen XM261 warheads (rounds No. ED172 through ED190) assembled to MK66 Mod 1 rocket motors were loaded into the M261 lightweight launcher (LWL) and subjected to test method MIS-33155 per paragraph 3.3.5.4.8.b for all three axes of vibration.

The disposition of the rounds is as follows:

a. After completion of the tactical vibration test, the continuity check showed that the M439 fuzes were normal on all 19 HE warheads.

b. Prior to firing, the continuity check showed that the M439 fuzes were normal on 18 of the 19 HE warheads. Warhead No. 177 indicated a short circuit in the M439 fuze. The warhead was examined by ARRADCOM and BEI personnel on 30 April 1981. The M439 fuze had a loose ground lead at the fuze connector. The ground lead was secured to the fuze connector and a retest indicated that the fuze was normal.

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5. "Sixth Letter Report of Engineer Design Test for the XM261, 2.75-Inch Rocket MPSM Warhead (Tactical Vibration Tests)," TECOM Project No. 4-MU-019-261-003, Yuma Proving Ground, Yuma, AZ, 25 June 1981.

c. On January 1981, 18 XM261 HE warheads were fired and all functioned satisfactorily. Warhead No. 177 was fired on 1 May 1981 and functioned satisfactorily.

d. The mean data of the XM261 HE warhead event are presented in table 2.

e. Functioning reliability of XM73 HE submunitions may be inferred from the overhead television if compared to the results of overhead television observation of XM75 training submunitions and the results of recovery of XM75 submunitions. Of the 145 XM75 submunitions recovered, 138 had functioned resulting in an actual functioning rate of 95.2 percent. Overhead TV recorded 98 functions for an observed rate of 64.1 percent of the 153 submunitions fired. Of 19 XM261 rounds fired (171 submunitions), overhead TV recorded 132 functions, or 77.2 percent. From this it could be inferred that XM73 function reliability is equivalent to XM75 function reliability.

Table 2. Summary data, XM261 warheads

XM261 samples	Temp conditioned (°F)[1]	Mean event position(m)[2] X	Y	Z	Fuze set time (sec)	Mean event time (sec)[3]
12	-50	-13.7	744.6	240.7	1.975	2.47
7	155	-21.1	713.6	236.9	1.975	2.41

1. Warheads were temperature conditioned during tactical vibration, but were fired at ambient temperature.

2. Y axis is the line of fire; X axis is perpendicular to the line of fire; Z axis is vertical, the height of burst above the launcher.

3. Event time was observed by range observers. Each HE warhead had lampblack forward of the M439 fuze. Warhead event position and event time were measured from lampblack signature as seen by the range observers. The lampblack signature was visible after the nine submunitions were ejected; thus, the event time was delayed by several hundred milliseconds.

XM267 Practice Warheads with XM75 Submunitions

Nineteen XM267 warheads (rounds no. ED165 through ED171 and ED235 through ED246) assembled to MK66 Mod 1 rocket motors were loaded into the M261 LWL and subjected to test method MIS-33155 per paragraph 3.3.5.4.8.b for all three axes of vibration.

The disposition of the rounds is as follows:

a. After completion of the tactical vibration test, the continuity check indicated that the M439 fuzes were normal on 17 XM267 warheads. Warheads No. 167 and 235 indicated a short-circuit in the M439 fuze.

b. Prior to firing, the continuity check indicated that the M439 fuze was normal on 18 of the 19 warheads. Warhead No. 167 continued to indicate a short-circuit in the M439 fuze. The warhead was examined by ARRADCOM and BEI personnel on 30 April 1981 revealing that the umbilical cord was short-circuited inside the warhead carrier assembly. The warhead was not fired.

c. On 20 and 21 January 1981, 18 XM267 warheads were fired and 17 functioned satisfactorily. Warhead No. 242 failed to function and ground impact of the round was not observed.

d. The mean data of the XM267 practice warhead event are listed in table 3.

e. A summary of XM75 submunition functional data is listed in table 4.

Table 3. Summary data, XM267 warheads

XM267 samples[1]	Rocket motor	Temp conditioned(°F)[2]	Mean event position (m)[3] X	Y	Z	Fuze set time (sec)	Mean event time (sec)[4]
7	MK66	155	-25.7	661.3	249.3	1.6	1.73
4	MK40	-50	-44.2	560.5	194.5	1.7	1.99

1. Total rounds for which warhead airburst event was observed and recorded.

2. Warheads were temperature conditioned during tactical vibration, but were fired at ambient temperature.

3. Y axis is the line of fire, zero at the launcher; X axis is perpendicular to the Y axis, right is positive, left is negative; Z axis is vertical, height above the launcher.

4. Event time was measured by Doppler radar.

Table 4. Summary, XM75 submunition function data

	-50°F	155°F	Overall
XM267 warheads fired	6	11	17
Total submunitions ejected	54	99	153
Total submunitions recovered	52	93	145
Submunitions failed to function	2	5	7
Submunitions functioned	50	88	138
% Functioning reliability	96.2	94.6	95.2
RADS unscrewed	0	5	5
Fuze assemblies separated from SMs	17	5	22

System Safety Tests (No. 7), 13 January 1981[6]

The system safety test was performed to determine if the XM261 MPSM warhead could withstand dynamic launch forces and to determine if performance degradation or malfunctions would result from the launch environment.

Twenty HE XM261 warheads with Naval Ordnance type (steel) nozzles (rounds no. ED141 through ED160) were assembled to MK66 Mod 1 rocket motors. The M439 fuze was set to function at 1.975 seconds corresponding to submunition ejection at approximately 1000 meters with submunition impacts at 1200 to 1300 meters from the firing position.

The mean function position was 988 meters downrange(line-of-fire), 26 meters left of the line-of-fire and 344 meters above the launcher. The mean observed time from launch to event time was 2.47 seconds.

Of 180 XM73 HE submunitions that were ejected from the XM261 HE warheads, 144 XM73 HE submunitions were observed on video to have functioned. Because of obscuration and video blooming, observation of about 50 percent of the submunitions that actually function is normally expected.

Submunitions of one XM261 HE round that functioned satisfactorily were heard but none were observed on video. This warhead event was 200 meters longer than the mean range (y - coordinate) because the warhead event occurred approximately 1/2 second late.

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6. "Seventh Letter Report on Engineer Design Test of MK66 Rocket/XM261 Submunition for 2.75-Inch Rocket (System Safety Tests)," TECOM Project No. 4-MU-019-261-003, Yuma Proving Ground, Yuma, AZ 18 June 1981.

Temperature Conditioning Test (No. 8), 26 and 27 January 1981[7]

The temperature conditioning test was conducted to determine if the 2.75-Inch XM261 MPSM warhead could withstand the temperature extremes expected during service life, and to insure that performance degradation or malfunctions will not be produced by the launch environment.

Sixty HE XM261 warheads (rounds no. ED11 through ED70) were temperature conditioned for a minimum of 12 hours as follows:

Warhead no.	Temperature (°F)
11-30	- 60 ± 5
31-50	145 ± 5
51-70	Ambient

Warheads no. 11 through 50 were assembled to MK66 Mod 1 rocket motors and warheads no. 51 through 70 were assembled to MK40 Mod 3 rocket motors.

A summary of airburst time and position is presented in table 13. Of the 20 warheads fired at each of the three temperature conditions, one failed to function at -50°F, two failed to function at ambient, and all functioned properly at 145°F. One warhead from each of the three temperature conditions functioned properly but the warhead function was unobserved because there was no black signature at the event.

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7. "Eighth Letter Report on Engineer Design Test for the XM261 2.75-Inch Rocket MPSM Warhjead (Temperature Conditioning Test)," TECOM Project No. 4-MU-019-261-003, Yuma Proving Ground, Yuma, AZ, 16 July 1981.

Sequential Rough Handling, Waterproofness, Transportation Vibration, and 40-Foot Drop Tests, TECOM Project No. 4-MU-019-261-003 (No. 9), 3 February through 1 May 1981 [8,9]

This group of tests on the XM261 MPSM warhead was performed to evaluate the following:

1. To determine if the warhead could withstand dynamic vibrational and/or possible dynamic impact stresses and to ensure that safety degradation of or performance would not be affected.

2. To determine if the warhead could withstand natural and induced environments and that safety and performance would not be degraded by exposure to these environments.

Thirty-four HE M261 MPSM warheads were serially numbered and subjected to the test as follows:

Test	Serial no.	Number of warheads
Sequential rough handling	ED207 through ED226	20
Waterproofness	ED163 and ED164	2
Transportation vibration	ED195 through ED202	8
40-foot drop	ED203 through ED206	4

Twenty XM261 HE warheads were packed in 5 boxes and subjected to the 7-foot packaged drop (17 February 1981). The PA89 fiber ammunition container for the XM261/XM267 rocket warhead failed to protect the rocket round satisfactorily. The warheads in box 2 that were temperature conditioned to 145°F (63°C) received severe nose cone damage. The warhead casepins or rivets sheared and/or elongated the rivet holes in the warhead case assembly (part no. 9334131), ARRADCOM Dwg. No. 9334097 (figs. 15 and 16). The warheads in boxes 4 and 5 that were temperature conditioned to -60°F (-51°C) were damaged during the 7-foot packaged drop. The warhead case assemblies were damaged by rivet hole elongation (figs. 17, 18 and 19).

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8. "Ninth and Final Letter Report of Engineer Design Test of XM261 Submunition Warhead for 2.75-Inch Rocket (Sequential Rough Handling, Waterproofness, Transportation Vibration and 40-Foot Drop Tests)," TECOM Project No. 4-MU-019-261-003, Yuma Proving Ground, Yuma, AZ, 3 September 1981.

9. "Correction to Ninth and Final Letter Report of Engineer Design Test of XM261 Submunition Warhead for 2.75-Inch Rocket (Sequential Rough Handling, Waterproofness, Transportation Vibration and 40-Foot Drop Tests)," TECOM Project No. 4-MU-019-261-003, Yuma Proving Ground, AZ, 17 September 1981.

The nose cone assemblies (part no. 9334119) were separated from the warhead case assembly (part no. 9334131). The shear pins were sheared on seven warheads and the sheared pins allowed the nose cone assembly to hang loosely at the mouth of the warhead case assembly.

Because of the inadequacy of the ammunition packing containers to protect the contents, and speculation that the assembly of the inert rocket motors may have contributed to the severity of the damage, the sequential rough handling test was rescheduled.

The XM261 HE warheads were dropped on 9 April 1981 and were again damaged in the 7-foot packaged drop. Four warheads had damaged nose cone assemblies (figs. 20 and 21). Seven warheads had elongated rivet holes in the warhead case assemblies (figs. 22 and 23). The fiber filler disc of three rocket rounds was cut by rocket motor nozzle assembly (fig. 24). The fiber ammunition packing containers proved inadequate for the rough handling 7-foot packaged drop.

Five XM261 HE warheads were exposed to the loose cargo test. Three of the warheads completed the close cargo test satisfactorily. After the loose cargo test was completed, the M439 fuze system continuity test revealed two XM261 warheads with open circuits.

There was no detonation or burning of the warheads after the 40-foot safety drop test.

Upon completion of the transportation-vibration test, the warheads were satisfactory.

There was no evidence of water in the warheads after the water-proofness test was completed.

Eight warheads which completed the foregoing tests with no physical or electrical damage were fired from a ground launcher for impact on Mullin's Square contaminated impact field. All eight rounds functioned satisfactorily.

The audio recorder instrumentation recorded nine XM73 HE submunition functions for each of the XM261 warheads fired.

Preproduction Test of Multipurpose Submunition Warhead/MK66 MOD 1 Rocket Motor, June and July 1982[10]

This preproduction test of the MPSM warhead and MK66 MOD 1 motor was performed to verify that the design changes made have corrected the deficiencies noted during the DT II. During this testing, five subtests were conducted:

a. Pack and packaging

b. MPSM M439 fuze function on arming

c. MPSM M439 fuze performance

d. MPSM M439 fuze and submunition M231 fuze performances, cold temperature

e. MPSM M439 fuze and submunition M231 fuze performances, aerial launch

Pack and Packaging

Sequential rough handling, consisting of a 7-foot package drop followed by an unpackaged loose cargo vibration test of complete rounds in individual fiber containers, was conducted on 10 M267 warheads with MK66 Mod 1 motors (rounds no. P1 through P10) and secured cargo vibration was conducted on 30 M267 warheads with MK66 Mod 1 motors (rounds no. P11 through P40). The units were divided into two groups, 155°F and -50°F, for each test.

The 7-foot packaged drop inspection results are found in table 5. The loose cargo vibration inspection results are found in table 6. There were no visible anomalies noted during the secured cargo vibration inspection.

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10. "Final Letter of Preproduction Test of Multipurpose Submunition Warhead/MK66 MOD 1 Rocket Motor," TECOM Project No. 4-MU-019-261-004, Yuma Proving Ground, Yuma, AZ, 24 Aubust 1982.

Table 5. Results of 7-foot drop inspection

Inspection items	Rocket and box numbers									
	High temp (68°C)					Low temp (-46°C)				
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Wood box deformed or broken				X					X	
Ends of fiber container deformed				X					X	
Masonite disc in fiber container motor end deformed		X					X			
Foam cushion and fiber filler deformed in wood box base end		X					X			
Nozzle end RADHAZ shield punctured		X								
Warhead nose cone loose			X	X					X	
M439 fuze circuit short or open					X					X

LEGEND: RADHAZ - Radiation Hazard

Table 6. Results of loose cargo vibration inspection

Inspection items	Rocket numbers									
	High temp (68°C)					Low temp (-46°C)				
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Nozzle end RADHAZ shield punctured		X*								
Warhead nose cone loose		X	X*	X*	X	X			X*	X
M439 Fuze circuit open	X				X*					

LEGEND: RADHAZ - Radiation Hazard

*Results previously noticed following 7-foot drop inspection.

Following the sequential rough handling test and prior to ground launching, three of the ten rockets (P1, P5 and P10) were found to have open warhead fuze circuits.

Of the 30 rockets subjected to the secured cargo vibration test, 2 rockets (P25 and P35) would not accept a correct fuze charge prior to ground launching attempts.

The warheads from these five rockets were investigated for failure analyses and the findings were as follows:

1. Round number P1 was found to have an open ground circuit caused by a cut in the flat flexible wire at the exit of the warhead casing wire channel. This cut in the flex cable was caused by lateral movement of the number 9 submunition.

2. Round number P5 was found to have an open circuit. Rotation of the number 9 submunition twisted the flat flexible wire at the exit of the warhead casing wire channel and broke the wire. The cable had also been cut by a drill during nose cone pin installation.

3. Round number P10 was found to have a connector disconnected from the fuze body terminal. Reassembly of the connector corrected the open circuit. The rocket was later ground-launched and the warhead functioned properly.

4. The M439 fuze on rocket P25 would not accept a good fuze charge. Both the warhead flex cable and the fuze were tested and found to have good continuity. The M439 fuze was returned to BEI for further analysis. The M439 fuze from warhead P1 was installed in warhead P25, the rocket was later ground-launched, and the warhead functioned.

5. The M439 fuze on rocket P35 would not accept a proper fuze charge. The fuze circuit continuity test indicated a short. The fuze was removed from the warhead but was left connected and a short was indicated by an ohmmeter check of the fuze. The nose cone was removed, all circuits tested and found to be functional. The submunitions were removed from the warhead and the flex cable was inspected. There was no evidence of a break in the flex cable; it was tested and found to be functional. The M439 fuze was returned to BEI for further analysis.

All eight[11] of the M267/MK66 rockets fired following the sequential rough handling test had proper warhead functions. Sixty-eight of the seventy-one M75 submunitions found functioned properly.

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11. Warhead P10 was repaired following the sequential rough handling test. Also, the motor on rocket P8 which would not fire was replaced with a motor from rocket P35 and successfully fired.

Twenty-nine of the thirty M267/MK66 rockets which had been subjected to secured cargo vibration were ground-launched. [12] Two of the M439 warhead fuzes (P13 and P39) failed to function. The warhead from rocket P36 functioned properly but none of the M75 submunitions could be found. Of the 243 M75 submunitions dispensed, 228 were found, 5 of which failed to function.

MPSM M439 Fuze Function on Arming

One hundred and four M439 fuzes (with 0.7 to 0.9 second delay time, modified to function on fuze arming) was installed in modified M229 flash warheads and assembled to MK66 Mod 1 motors. Thirty-five rockets were temperature conditioned at 155°F, thirty-five at -55°F and thirty-four at 72°F for a minimum of 24 hours, then launched from an M260 7-tube lightweight launcher on a ground mounting fixture.

Round-by-round ground launch data, providing conditioning temperatures, function times, and function distances for 103 rockets launched are summarized in table 14.

Of 35 high temperature samples, 8 were no-tests, 1 was a long function, and 26 were considered for statistical test sampling. The average fuze function time was 0.745 seconds and the average fuze function distance was 575 feet.

Of 34 ambient temperature samples, 10 were no-tests, 6 were long functions, and 18 were considered for statistical sampling. The average fuze function time was 0.750 seconds and the average fuze function distance was 541 feet.

Of 34 cold temperature samples, 17 were no tests, [13] 1 had no data taken, 1 was a long function, and 15 were considered for statistical test sampling. The average fuze function time was 0.872 seconds and the average distance to fuze function was 625 feet.

None of the fuzes tested were considered to have functioned early enough to pose a safety hazard.

The high no-test rate is attributed to the fact that the fuzes had been modified to function upon arming.

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12. Both P25 and P35 had malfunctioning 439 fuzes. P25 was fired with a different M439 fuze. P35 was not fired.

13. Fifteen rounds did not function and two were fired at a too low launch angle.

M439 Fuze Performance

Fifty six M439 fuzes (with 0.7 to 0.9 second arming time) were provided for testing. Environmental tests were conducted on 34 of the 56 fuzes at the mamufacturer's (BEI) facility prior to delivery to Yuma Proving Ground. Thermal shock testing was conducted on 17 of the fuzes and simulated helicopter vibration testing was conducted on 17 fuzes. No environmental tests were conducted on 16 fuzes which were used as control rounds in statistical evaluation. The remaining six fuzes were used for instrumentation checkout. The fuzes were installed in modified M229 flash warheads, assembled to MK66 Mod 1 motors, temperature conditioned and launched from an M260 7-tube lightweight launcher on a ground mounting fixture.

Round-by-round ground launch data, providing conditioning temperatures, fuze pretest environments, fuze set times and fuze function times are summarized in Table 15. All 49 rockets launched had properly functioning M439 warhead fuzes.

MPSM 439 Fuze and Submunition M231 Fuze Performances, Low Temperatures

Forty M267 warheads with MK66 Mod 1 motors (rounds no. F1 through F40) were temperature conditioned at -50°F for a minimum period of 24 hours. The rounds were launched from an M260 7-tube lightweight launcher on a ground mounting fixutre. Four rounds were launched at a 1000 meter target, 18 were launched at a 3000 meter target and 18 were launched at a 6000 meter target.

Round-by-round ground launch data, providing such information as fuze set times, fuze function times, rocket velocities at fuze functions, and number of SM functions, are found in Table 16.

Warheads and submunitions from the 40 rockets were launched and evaluated for warhead M439 fuze reliability and for submunition M231 fuze reliability.

All 40 warhead M439 fuzes functioned properly.

Of the 360 M75 submunitions dispensed, 355 were recovered, 13 of which failed to function.

Stadia data are available upon request.

MPSM M439 Fuze and Submunition M231 Fuze Performances, Aerial Launch

Twenty M267 warheads with MK66 Mod 1 motors (rounds no. F41 through F60) were temperature conditioned at 155°F for a minimum of 24 hours. The 20 rounds were removed from temperature conditioning and aerial launched, single fire, from an AH-1S Modernized Cobra (MC) at ambient desert conditions.

Round-by-round warhead and submunition performance data are summarized in table 7.

Rocket F51 impacted the ground short of the intended target without functioning properly. This rocket was considered to be a warhead and submunition no-test because it was launched with insufficient aircraft pitch-up (pilot error).

Rocket F52 functioned beyond the intended target, either shortly before or after impact and only a few submunitions functioned. This was considered a warhead failure and a submunition no-test.

Of the 162 submunitions properly dispensed, 1 was not found and 1 failed to function properly.

Table 7. Round-by-round submunition fuze reliability data, aerial firing

Round no	No. SM functions found	No. SM functions	No. SM duds	Remarks
F41	9	9		
F42	9	9		
F43	9	9		
F44	9	9		
F45	9	8	1	No. 4 armed; not triggered
F46	9	9		
F47	9	9		
F48	9	9		
F49	9	9		
F50	9	9		
F51	1	1		Round went into ground - no test
F52	0			RADs not deployed-late M439 function
F53	9	9		
F54	9	9		
F55	9	9		
F56	9	9		
F57	9	9		
F58	9	9		
F59	9	9		
F60	8	8		
Totals	162	161	1	

LEGEND: RAD - Ram air decelerator

CONCLUSIONS

Development Test II (DT II) (PQT-G) of the MK66 MOD 1 rocket motor and Multipurpose Submunition (MPSM) Warhead was conducted at U.S. Army Yuma Proving Ground (YPG) during the period of March to November 1981. Results of the DT II showed deficiencies in the MPSM M439 fuze at low temperatures, and in complete round packaging. On 26 February 1982, the M267/M261 MPSM warhead and MK66 MOD 1 motor were type classified Standard with the restriction that the FY82 production contract be withheld until successful demonstration of corrections to the DT II deficiencies.

The preproduction test of the MPSM warhead and MK66 MOD 1 motor was performed to evaluate the deficiencies noted during DT II and to provide the additional testing for reliability. The deficiencies can be grouped into three categories. The test results and conclusions are listed below:

1. The package modifications made for the preproduction test were in the nose end and base end of the fiber container. The nose cone support material was changed to a medium density cellulose fiber board with a felt pad attached. The base support was changed to a hard pressed building board (hardboard) with a felt ring attached. These changes allowed the rocket to be supported at both ends without degradation of the packing material during temperature conditioning and testing. The preproduction test results validated the correction of the deficiencies noted during DT II.

2. a. M439 arming distance.

This test was required to validate safe separation distance for the M439 fuze when fired with the MK66 Mod 1 motor.

The fire in arming rounds tested showed average arming distances:

Hot - 575 ft.
Ambient - 541 ft.
Cold - 625 ft.

Minimum arming distance was 500 ft. which is considered to impose no safety hazard to the aircraft.

b. M439 fuze functional reliability.

Forty nine rounds were fired in this test resulting in forty nine functions.

3. To improve the grenade functional reliability, an obturator support and obturator o-ring was placed on the first (bottom) grenade in the stack. The obturator trapped the hot gases and particles below the first fuze and allowed the stack to be ejected without the possibility of foreign material entering the M230/M231 fuze. During the preproduction tests the grenade functional reliability was found to be significantly greater than previous tests. The reliability was found to be 96.8% for ground launched warheads and 99.4% for aerial launched warheads.

REFERENCES

1. W.S. Marks, "Engineering Development of the XM261 Multipurpose Submunition Warhead for the 2.75-Inch FFAR," ARDC Contractor Report DAAK10-79-C-0078, BEI Electronics, Inc., Euless, TX, July 1980.

Table 8. Summary of metal parts evaluation, XM261 submunition warhead

Rd no	No of submunitions recovered	Submunitions failed to eject from warhead	Satisfactory submunition function	Submunition failed to arm	Submunition partially armed	Items separated from submunition				Condition of stak	
						RAD	XM230 fuze	Booster pellet	Main charge	Poor	Eccentric
Metal Parts Security Phase											
1	9	5	0	1	0	3	2	0	0	3	0
2	8	0	2	0	0	6	6	0	0	2	0
3	9	0	5	1	0	3	3	0	0	1	0
4	9	0	5	2	2	0	0	0	0	0	1
5	9	0	5	2	1	1	1	0	0	0	0
6	8	0	6	1	1	0	0	0	0	0	0
9	8	0	7	1	0	0	0	0	0	0	0
10	9	0	9	0	0	1	0	0	0	0	0
System Safety Phase											
131	9	0	8	0	0	2	1	1	1	1	0
132	9	0	8	1	0	0	0	0	0	0	0
133	9	0	9	0	0	0	0	0	0	0	0
134	9	0	7	2	0	0	0	0	0	1	1
135	9	0	5	1	0	3	3	3	1	2	0
136	8	0	7	1	0	0	0	0	0	0	0
137	9	0	7	0	0	2	2	1	0	0	1
138	7	0	4	0	0	3	3	2	1	1	0
140	9	0	8	1	0	0	0	0	0	0	1

Table 9. Round-by-round data EDT XM267 warhead/MK66 rocket motor

Rd No.	Time Fired (MST)	Warhead Type	Warhead Set No.	Warhead Wt (lb)	Warhead Temp (°F)	Rocket Motor Ser No.	Rocket Motor Nozzle	Launcher Type	Launcher Tube No.	Launcher Q.E. (μ)	M439 Fuze* Set (sec)	M439 Fuze* Chg Sqmr	Wind Dir (T°N)	Wind Vel (MPS)	Warhead Event Ht (m)	Warhead Event Time (sec)	Warhead Event Vel (MPS)	Submunitions F	Submunitions FF	Submunitions NR	Laser Track	Remarks
Date Fired: 2 December 1980 Nominal Range: 6000 meters						Line of Fire: 15°		*Launcher Z: -59 meters					Type Launcher: XM260 (7-tube), serial No. 0026									
5-1	1337	M230	-	-	-	-	-	XM260	1	305	-	-	-	-	-	-	-	-	-	-	No	Doppler Tracking Round
5-2	1343	M230	-	-	-	-	-				-	-	-	-	-	-	-	-	-	-		Doppler Tracking Round
1	1401	XM267	114	14.59	155	81A	5hort				18.4	5at.	230	02.5				1	7	1		The warhead event was extremly low.
2	1420		115	14.53		82A							210	02.0	NO	NT	NM	0	9	0		The firing was delayed due to two misfires caused by difficulty of the interface between the MK66 motor with the short nozzle with the XM260 launcher. The warhead failed to function. The fuze charge was lost due to inability to launch the rocket from the XM260 launcher. All submunitions were in warhead when it was recovered.
3	1439		113	14.56		80A							190	01.5	NO	NT	NM	0	9	0		The firing was delayed due to two misfires. The warhead functioned on impact. The indication was that the fuze charge was lost due to the delay in firing.
4	1450		111	14.51		74A							220	01.5	NO	NT	NM	0	9	0	No	The warhead functioned on impact.
5	-		112	14.52		79A							250	02	-	-	-	-	-	-	-	Round failed to fire from launcher. Round was removed from launcher because fuze set time was drained off.
6	-		119	14.57	155	75A	5hort		1	305			240	02	-	-	-	-	-	-	-	Same as round No. 5
7	-	XM267	71	14.54	Amb	168EI	Long	XM260	2	338	18.4	5at.	220	02	-	-	-	-	-	-	-	Same as round No. 5 Firing was cancelled due to the difficulty of interface between the MK66 rocket motor with the XM260 launcher.
Date Fired: 4 December 1980 Nominal Range: 6000 meters						Line of Fire: 15°		**Launcher Z: -59 meters					Type Launcher: M158A1E1, serial No. 034									
8	1251	M257	1	-	Amb	4-Tm	5hort	M158-A1E1	3	427	-	-	NM	NM	-	-	-	-	-	-	-	Deployment of parachutes and ignition of candle were satisfactory.
9	1302		2	-		18	5hort			515	-	-	-CALM--		-	-	-	-	-	-	-	Same as round No. 8
10	1311	M257	3	-	Amb	2532	Long	M158-A1E1	3	480	-	-	NM	NM	-	-	-	-	-	-	-	Same as round No. 8

*Umbilical continuity check - normal except as noted.
**Launcher Z is height of launcher above or below target level. Negative is below target.

Table 9. (cont)

Rd No.	Time Fired (MST)	Warhead Type	Warhead Set No.	Warhead Wt (lb)	Warhead Temp (°F)	Rocket Motor Ser No.	Rocket Motor Nozzle	Launcher Type	Launcher Tube No.	Q.E. (mil)	M439 Fuze* Set (sec)	M439 Fuze* Chg Sgmr	Wind Dir (T°N)	Wind Vel (MPS)	Warhead Event Ht (m)	Warhead Event Time (sec)	Warhead Event Vel (MPS)	Submunitions F	Submunitions FF	Submunitions NR	Laser Track	Remarks
11	1318	M257	4	-	Amb	430	Long	M158-A1E1	3	480	-	-	-	-	-	-	-	-	-	-	-	No parachute deployment/no flare function.
12	1322	M257	5	-	Amb	2258	Long	"	"	480	-	-	-	-	-	-	580	-	-	-	-	Same as round No. 8
13	1329	M257	6	-	Amb	2508	Long	"	"	480	-	-	-	-	-	-	633	-	-	-	-	Same as round No. 8
14	1350	XM267	93	14.53	-50	51A	Short	"	"	327	18.2	Sat.			NO	NT	NM	9	0	0	No	
15	1405	"	94	14.55	-50	68A	Short	"	"	"	"	"	230	01	NO	20.2	180	7	0	2	No	
16	1412	"	97	14.53	-50	53A	Short	"	"	"	"	"			NO	NT	NM	8	0	1	No	
17	1452	"	74	14.50	Amb	19BEI	Long	"	"	"	"	"			407	18.2	196	8	1	0	Yes	
18	150S	"	73	14.55	"	20BEI	"	"	"	"	"	"	250	04	347	19.8	198	7	1	1	"	
19	1511	"	75	14.52	"	18BEI	"	"	"	"	18.2	"			339	19.6	201	9	0	0	"	
20	1521	"	71	14.54	"	17BEI	"	"	"	"	18.2	"			320	19.9	193	8	1	0	"	
21	1527	"	72	14.53	Amb	16BEI	Long	"	"	327	18.2	"			NO	19.7	191	7	1	1	Yes	
22	1620	"	112	14.52	155	70A	Short	"	"	363	17.7	"	230	05	NO	NT	NM	2	5	2	No	
23	1629	"	117	14.53	155	101B	"	"	"	"	"	"			388	"	"	8	1	0	"	
24	1638	"	119	14.57	155	1008	"	"	"	"	"	"			NO	"	"	0	0	0	"	Warhead failed to function.
25	1643	"	91	14.53	-50	102B	"	"	"	"	"	"			NO	"	"	7	0	2	"	
26	1648	"	92	14.50	"	103B	"	"	"	"	"	"			411	"	"	7	2	0	"	
27	1655	"	95	14.55	"	73A	"	"	"	"	"	"			428	"	"	8	1	0	"	
28	1700	XM267	98	14.56	-50	77A	Short	M158-A1E1	3	363	17.7	Sat.			NO	NT	NM	8	0	1	No	

Date Fired: 8 December 1980
Nominal Range: 3000 meters Line of Fire: 15°F **Launcher Z: -29 meters Type Launcher: M158E1, serial No. 034

S-6	1306	M230	-	-	-	-	-	M158-A1E1	3	245	-	-	-	-	-	-	-	-	-	-	-	Doppler tracking unit malfunctioned. The decision was made to continue the test without the HAWK Doppler Radar.
		XM267	116	14.57	1S5	7SA	Short	"	"	"	-	-	-	-	-	-	-	-	-	-	-	The XM267 warhead was not fired because the umbilical continuity check showed a short in the warhead. Rocket motor was disassembled from the warhead.
29	1349	"	123	14.54	"	75A	"	"	"	"	5.7	Sat.	305	03	269	NT	NM	8	1	0	No	
30	1400	"	120	14.54	"	79A	"	"	"	"	"	"	340	05.S	270	"	"	7	2	"	"	
31	1409	"	124	14.57	"	5	"	"	"	"	"	"	350	07	300	"	"	7	2	"	"	
32	1418	"	118	14.51	"	3 TM	"	"	"	"	"	"	340	06	NO	"	"	8	1	"	"	
33	1427	"	121	14.55	155	87A	Short	"	"	"	"	"	360	06.5	333	NT	NM	9	0	"	No	
34	1439	"	80	14.60	Amb	3BEI	Long	"	"	"	"	"	345	03.S	370	6.6	324	9	0	"	Yes	
35	1448	"	79	14.56	"	4BEI	"	"	"	"	"	"	350	04.5	NO	NT	NM	8	1	"	Yes	
36	1613	"	77	14.56	"	18EI	"	"	"	"	"	"	360	05.S	314	7.0	311	9	0	0	"	
37	1618	"	78	14.59	"	28EI	"	"	"	"	"	"	345	06	355	6.7	319	7	1	1	"	
38	1634	"	76	14.56	"	11BEI	"	"	"	"	"	"	340	05.S	-	-	-	-	-	-	"	Warhead failed to function. Two attempts were made to fire and both firings were aborted because the laser could not maintain lock. The fuze charge could have been lost due to the delay in firing.
39	1640	XM267	81	14.61	Amb	12BEI	Long	M158-A1E1	3	245	5.7	Sat.	325	06	347	6.9	290	9	0	0	Yes	

Table 9. (cont)

Rd No.	Time Fired (MST)	Warhead Type	Warhead Set No.	Warhead Wt (lb)	Warhead Temp (°F)	Rocket Motor Ser No.	Rocket Motor Nozzle	Launcher Type	Launcher Tube No.	Q.E. (mils)	M439 Fuze* Set (sec)	M439 Fuze* Chg Sgmr	Wind Dir (T°N)	Wind Vel (MPS)	Warhead Event Ht (m)	Warhead Event Time (sec)	Warhead Event Vel (MPS)	Submunitions F	Submunitions FF	Submunitions NR	Laser Track	Remarks
40	1644	XM267	84	14.56	Amb	98EI	Long	M158-A1E1	3	245	5.7	Sat.	350	06.5	339	6.9	305	9	0	0	Yes	
41	1650	"	83	14.58	Amb	108EI	Long	"	"	"	"	"	335	05	316	7.0	302	8	1	0	Yes	
42	1656	"	82	14.55	Amb	148EI	Long	"	"	"	"	"	320	04	391	6.S	324	9	0	0	Yes	
43	1706	"	122	14.53	155	60A	Short	"	"	"	"	"	330	04	356	6.3	319	7	1	1	No	
44	1710	"	96	14.48	-50	71A	"	"	"	"	"	"	330	05.5	255	NT	NM	8	1	0	"	
45	1720	"	103	14.58	"	76A	"	"	"	"	"	"	345	05	300	"	"	1	0	8	"	Round functioned approximately 800 meters long.
46	1724	"	101	14.58	"	78A	"	"	"	"	"	"	340	03.5	250	"	"	8	1	0	"	
47	1727	"	99	14.55	"	89A	"	"	"	"	"	"	340	04	202	"	"	9	0	0	"	
48	1732	"	102	14.56	"	90A	"	"	"	"	"	"	335	04	352	"	"	8	0	1	"	
49	1735	"	104	14.55	"	88A	"	"	"	"	"	"	335	04.5	287	"	"	7	2	0	"	
50	1739	XM267	100	14.54	-50	61A	Short	M158-A1E1	3	245	5.7	Sat.	330	03	NO	NT	NM	-	-	-	No	Warhead failed to function

Oate Fired: 10 Oecember 1980
Nominal Range: 1000 meters Line of Fire: 340.7° **Launcher Z: 3 meters Type Launcher: M158A1E1, serial No. 034
Oue to high winds at 5 to 10K feet, the test firing was conducted without the aircraft with overhead TV.

S-7	1545	M230	-	-	-	-	-	M158-A1E1	3	434	-	-	-	-	-	-	-	-	-	-	-	Ooppler tracking round
S-8	1552	M230	-	-	-	-	-	"	"	"	-	-	-	-	-	-	-	-	-	-	-	Ooppler tracking round
S-9	1609	M230	-	-	-	-	-	"	"	"	-	-	290	07.5	-	-	-	-	-	-	-	Ooppler tracking round
51	1618	XM267	107	14.53	-50	67A	Short	"	"	"	1.6	Sat.	310	07	449	NT	NM	7	2	0	No	
52	1623	"	108	14.56	"	66A	"	"	"	"	"	"	330	06.5	253	1.7	505	8	1	0	"	
53	1626	"	106	14.S3	"	62A	"	"	"	"	"	"	330	08	NO	1.7	505	6	1	2	"	Observed no lampblack at whd event.
54	1630	"	109	14.52	"	37A	"	"	"	"	"	"	320	08	312	NT	NM	8	0	1	"	
55	1634	"	105	14.55	-50	64A	"	"	"	"	"	"	330	06.S	239	1.S	505	7	1	1	"	
56	1642	"	125	14.51	155	65A	"	"	"	"	"	"	330	07	NO	NT	NM	7	2	0	"	
57	1646	"	129	14.53	"	29A	"	"	"	"	"	"	320	06.5	278	NT	NM	7	2	0	"	
58	1649	"	128	14.52	"	26A	"	"	"	"	1.6	"	340	05.5	253	NT	NM	8	1	0	"	
59	1653	"	127	14.50	"	28A	"	"	"	"	-	"	350	07.5	584	4.4	455	9	0	0	"	Round functioned long
60	1657	XM267	126	14.52	155	27A	Short	M158-A1E1	3	434	1.6	Sat.	320	06	242	1.S	531	0	0	9	No	

Oate Fired: 16 Oecember 1980
Nominal Range: 1000 meters Line of Fire: 22° **Launcher Z: -10 meters Type Launcher: M158A1E1, serial No. 034

S-10	120S	WTU 1/8	-	-	-	-	-	M158-A1E1	3	434	-	-	-	-	-	-	-	-	-	-	-	Ooppler tracking round
S-11	1211	WTU 1/8	-	-	-	-	-	"	1	"	-	-	-	-	-	-	-	-	-	-	-	Ooppler tracking round
61	1401	XM267	90	14.62	Amb	68EI	Long	"	3	"	1.6	Sat.	340	05	237	1.6	519	6	1	2	Yes	
62	-	"	87	14.6S	"	138EI	"	"	"	"	-	-	-	-	-	-	-	-	-	-	-	Round had an open umbilical and was not fired.
63	1417	"	89	14.S5	"	5BEI	"	"	"	"	1.6	Sat.	330	07.5	222			7	0	2	Yes	
64	1422	"	85	14.60	"	8BEI	"	"	"	"	"	"	340	07.5	220	1.6	519	7	0	2	"	
65	1426	"	88	14.55	"	78EI	"	"	"	"	"	"	330	08	297			6	1	2	"	
66	1429	XM267	86	14.63	Amb	15BEI	Long	M158-A1E1	3	434	1.6	Sat.	340	07	235			4	1	4	Yes	

LEGENO: Amb - Ambient temperatures FF - Failed to function NO - Not observed NT - Not taken
F - Functioned NM - Not measured NR - Not recnvered S - Spotter round (MK40 rocket motor)

Table 10. Submunition function data, XM267 warhead, EDT-G

Whd temp cond (°F)	Round no./whd ser no	Submunition serial no. 1 2 3 4 5 6 7 8 9	Remarks
Date Fired: 2 December 1980 Range: 6000 meters			
155	1/114		XM267 functioned very close to the ground. Results were as follows: (1) 6 submunitions were exposed, were armed, and were classified as duds. (2) Fuze assembly separated from one submunition. (3) One submunition functioned satisfactorily. (4) One submunition was not recovered.
155	2/115		XM267 warhead failed to function on impact.
155	3/113		XM267 warhead functioned on ground impact. None of the submunitions were recovered.
155	4/111		XM267 warhead event was very close to ground impact. Three submunitions were ejected and failed to function. Six submunitions failed to eject.
Date fired: 4 December 1980 Range: 6000 meters			
-50	14/93	S S S S S S S S S	
-50	15/94	S L S S S S S S L	
-50	16/97	S L S S S S S S S	Submunitions 6 and 9 when recovered were separated from the XM230 fuze.
Amb	17/74	S D S S S S S S S	Bore rider was not extended and trigger was in placed on submunition 2.
Amb	18/73	S S S S S L S S D	Bore rider was missing on submunition 9. Submunition 3 was separated from the XM230 fuze.
Amb	19/75	S S S S S S S S S	
Amb	20/71	S D S S S S S S S	Bore rider was not extended and trigger was in placed on submunition 2.
Amb	21/72	S S S S S S S D L	Bore rider was partially extended on submunition 8.

Table 10 (cont)

Whd temp cond (°F)	Round no./whd ser no	Submunition serial no. 1 2 3 4 5 6 7 8 9	Remarks
155	22/112	L S D D S D D L D	Bore rider was not extended on submunitions 4,6, and 9. Bore rider was partially extended on submunition 7. Bore rider was fully extended on submunition 3. Fuze housing was broken and firing pin retainer came off on submunition 9.
155	23/117	S S S D S S S S S	Bore rider was not extended on submunition 4.
155	24/119		XM267 warhead failed to function.
-50	25/91	S S S S S S L S L	
-50	26/92	S D S S S S S S D	Bore rider was extended and firing pin was not extended on submunition 2 and 9.
-50	27/95	S S D S S S S S S	Firing pin and bore rider were extended on submunition 3.
-50	28/98	S S S S S L S S S	
Date fired: 8 December 1980 Range: 3000 meters			
155	116	S S D S S S S S S	XM267 warhead was not fired because the continuity check showed a shorter umbilical.
155	29/123	S S D S S S S S S	Bore rider was not extended on submunition 3.
155	30/120	S D D S S S S S S	Bore rider was not extended on submunition 2. Bore rider was extended and firing pin was not extended on submunition 3.
155	31/124	S D D S S S S S S	Bore rider was not extended on submunition 3. Bore rider was extended and firing pin was not extended on submunition 2.
155	32/118	S S S S D S S S S	Bore rider was extended and firing pin was not extended on submunition 5.
155	33/121	S S S S S S S S S	
Amb	34/80	S S S S S S S S S	
Amb	35/79	D S S S S S S S S	Bore rider was not extended on submunition 1.
Amb	36/77	S S S S S S S S S	
Amb	37/78	D S S S S S S L S	Bore rider was not extended on submunition 1. Fuze was separated from submunition 2.

Table 10 (cont)

Whd temp cond (°F)	Round no./whd ser no	Submunition serial no. 1 2 3 4 5 6 7 8 9	Remarks
Amb	38/76		XM267 warhead failed to function.
Amb	39/81	S S S S S S S S S	
Amb	40/84	S S S S S S S S S	
Amb	41/83	D S S S S S S S S	Bore rider was partially extended on submunition 1.
Amb	42/82	S S S S S S S S S	
155	43/122	S S S S D S L S S	Firing pin was extended on submunition 5. Fuze was separated from submunition 2.
-50	44/96	S S S S S D S S S	Bore rider was extended and firing pin was not extended on submunition 6.
-50	45/103	L L L S L L L L L	
-50	46/101	S D S S S S S S S	Bore rider was extended and firing pin was not extended on submunition 2.
-50	47/99	S S S S S S S S S	
-50	48/102	S S S L S S S S S	
-50	49/104	D S S S S S S D S	Bore rider was not extended on submunition 1. Bore rider was partially extended on submunition 8.
-50	50/100		XM267 warhead failed to function.
Date fired: 10 December 1980 Range: 1000 meters			
-50	51/107	D S S D S S S S S	Bore rider was extended and firing pin was not extended on submunitions 1 and 4.
-50	52/108	S S S S S S S D S	Bore rider was not extended on submunition 8.
-50	53/106	S S L L D S S S S	Bore rider was extended and firing pin was not extended on submunition 5.
-50	54/109	L S S S S S S S S	
-50	55/105	S S S L D S S S S	Bore rider was not extended on submunition 5.
155	56/125	S S D S S D S S S	Bore rider was extended and firing pin was not extended on submunitions 3 and 6.
155	57/129	S D D S S S S S S	Bore rider was not extended on submunition 2. Bore rider was extended and firing pin was not extended on submunition 3.

Table 10 (cont)

Whd temp cond (°F)	Round no./whd ser no	Submunition serial no. 1 2 3 4 5 6 7 8 9	Remarks
155	58/128	S S D S S S S S S	Bore rider was not extended on submunition 3.
155	59/127	S S S S S S S S S	
155	60/126	L L L L L L L L L	
Date fired: 16 December 1980			
Range: 1000 meters			
Amb	61/90	D S S S L S S L S	Bore rider was partially extended on submuition 1.
Amb	62/87		XM267 warhead was not fired because the continuity check showed an open umbilical.
Amb	63/89	L S S L S S S S S	
Amb	64/85	L S S S S S S S L	
Amb	65/88	S D S L S S L S S	Bore rider was extended and firing pin was not extended on submunition 2.
Amb	66/68	D S S S L S L L L	Bore rider was extended on submunition 1.
Date fired: 13 December 1980			
	110	L L L L L L L L L	
	130	S S D S S S S S D	Bore rider was not extended on submunitions 3 and 9.

LEGEND: S - Submunitions functioned satisfactorily
D - Submunition failed to function
L - Submunition was not recovered

Table 11. Airburst data XM267 submunition warhead, EDT-G

Round no.	Range[5] (m)	Observer data (m)			PATS Break-lock[2] (m)			HAWK Doppler TOF (sec)	HAWK Doppler Velocity (mps)
		Range[3]	Def[4]	Height	Range[3]	Def[4]	Height		
17	5875	-	-	-	-17	68R	407	18.7	196
18		-	-	-	119	93R	347	19.8	198
19		-221	(6)	(6)	-207	22L	339	19.6	201
20		121	(6)	(6)	171	5R	320	-	193
21		108	(6)	(6)	-----Indeterminate-----			-	-
22		-	-	-	--Not laser tracked---			-	-
23		166	91R	388				-	-
24		-	-	-				-	-
25		147	(6)	(6)				-	-
26		-8	234L	411				-	-
27		-98	215L	428				-	-
28	5875	-	-	-				-	-
29	3000[7]	-244	[7]47L	[7]269				-	-
30		-207	23L	270				-	-
31		-222	35L	300				-	-
32		-	-	-				-	-
33		-305	73L	333	--Not laser tracked---			-	-
34		-313	15L	380	-318	10R	370	6.5	324
35		-	-	-	-	-	-	-	-
36		[7]-152	[7]86R	[7]313	-	65R	314	7.0	311
37		[7]-237	[7]46L	[7]355	-	31L	355	6.7	319
38		-	-	-	-	-	-	-	-
39		-189	75L	336	-105	68L	347	-	-
40	3000	[7]-163	[7]49L	[7]338	-103	32L	339	-	-

[1] Position, relative to target, of airburst signature

[2] Position, relative to target, of laser tracker break-lock. Point at which laser stopped tracking the nose cone retroreflectors.

[3] Distance from target, along the line-of-fire of event. Negative is short target.

[4] Distance perpendicular from line-of-fire of event. "L" is left, "R" is right looking downrange.

[5] Fuzes were set for nominal ranges. Data were corrected to place the target at the nominal range. The data herein and in table 12 are in the same reference system.

[6] Single-observer solution. Questionable data.

[7] Excessive residuals in solution. Questionable data.

Table 11 (cont)

Round no.	Range (m)	Observer data (m)			PATS Break-lock (m)			HAWK Doppler TOF (sec)	HAWK Doppler Velocity (mps)
		Range	Defl	Height	Range	Defl	Height		
41	3000	-143	2R	310	-	1L	316	6.9	314
42		-288	83L	391	--Not laser tracked---			6.5	324
43		-419	77L	356				6.3	319
44		-293	4L	255				-	-
45		[7]870	[7]25R	[7]300				-	-
46		[7]-342	[7]24L	[7]250				-	-
47		-318	37L	202				-	-
48		[7]-326	[7]59L	[7]352				-	-
49		-450	13L	287				-	-
50	3000	-	-	-				-	-
51	950	402	11R	459				-	-
52		-360	19R	253				1.7	505
53		-	-	-				1.7	505
54		-127	27L	312				-	-
55		-260	12R	239				1.5	505
56		-	-	-				-	-
57		-243	27R	278				-	-
58		-354	5L	253				-	-
59		803	13R	584				4.4	455
60	950	-381	5R	242	--Not laser tracked---			1.5	531
61	993	-391	23R	237	-----Indeterminate----			1.6	519
63		-367	10L	222				-	-
64		-378	21R	220				1.6	519
65		-203	13L	297				-	-
66	993	-372	46L	235	-----Indeterminate----			-	-

NOTE: Dashes in columns indicate data were not taken

Table 12. Impact scoring data XM267 warhead, EDT-G

Whd temp cond (°F)	Round no.	Warhead no.	X Impact (meters) X Axis	X Mean	X Std dev	X Max spread	Y Impact (meters) Y Axis	Y Mean	Y Std dev	Y Max spread
Date fired: 4 December 1980										
Nominal range: 6000 meters					Line of fire:		15°			
-50	14	93	57.8	48.18	6.92	19.4	174.9	164.26	16.94	36.3
			49.7				178.1			
			38.4				175.1			
			47.7				150.8			
			47.3				141.8			
-50	15	94	-44.3	-38.27	14.34	26.7	353.2	354.20	22.92	45.8
			-21.9				377.6			
			-48.6				331.8			
-50	16	97	-65.4	-64.30	3.97	7.7	-55.7	-67.17	10.19	19.5
			-59.9				-70.6			
			-67.6				-75.2			
Amb	18	73	-72.8	-87.5	11.03	26.9	451.7	437.65	17.41	31.9
			-87.3				421.8			
			-99.7				453.7			
			-88.4				423.4			
Amb	19	75	33.3	40.82	10.62	27.3	68.9	74.03	12.56	37.0
			31.5				55.2			
			58.8				80.2			
			44.1				69.4			
			32.4				78.3			
			44.8				92.2			
Amb	20	71	-6.9	-18.33	12.67	29.5	419.2	413.1	12.33	26.6
			-16.0				417.0			
			-14.0				421.4			
			-36.4				394.8			
Amb	21	72	45.1	36.96	15.07	34.7	425.5	429.1	6.52	15.7
			10.4				422.9			
			45.1				425.5			
			45.1				438.6			
			39.1				433.0			
155	23	117	46.3	44.63	6.30	14.6	463.9	454.92	9.61	24.0
			48.3				468.0			
			48.6				447.4			
			37.0				449.4			
			51.1				444.0			
			36.5				456.8			

NOTE: These data were corrected to the nominal firing range, and are in the same reference system as the data in Enclosure 3.

Table 12 (cont)

Whd temp cond (°F)	Round no.	Warhead no.	X Impact (meters) X Axis	X Mean	X Std dev	X Max spread	Y Impact (meters) Y Axis	Y Mean	Y Std dev	Y Max spread
-50	25	91	24.1	56.71	16.73	49.3	420.4	446.29	19.09	48.2
			66.1				427.1			
			63.3				466.4			
			73.4				468.6			
			66.6				435.2			
			46.3				457.0			
			57.2				449.3			
-50	26	92	-278.1	-277.84	7.67	19.9	283.5	269.78	10.82	24.4
			-275.8				262.0			
			-273.8				265.3			
			-270.8				279.0			
			-290.7				259.1			
-50	27	95	-217.7	-224.32	8.54	24.0	220.1	210.0	9.38	21.6
			-235.4				207.9			
			-229.0				199.3			
			-227.3				220.9			
			-211.4				211.4			
			-225.1				200.1			
-50	28	98	-43.1	53.30	14.51	42.5	342.4	346.87	17.63	48.9
			-45.2				352.7			
			-66.9				321.8			
			-54.0				367.0			
			-54.6				338.3			
			-75.9				335.2			
			-33.4				370.7			
Date fired: 8 December 1980										
Nominal range: 3000 meters					Line of fire:		15°			
155	29	123	-18.4	-22.0	8.89	24.4	53.4	40.92	8.96	22.7
			-35.4				30.7			
			-11.0				42.4			
			-28.6				39.4			
			-21.4				48.0			
			-16.8				31.6			
155	30	120	4.7	0.88	3.50	8.4	66.3	72.0	5.26	12.6
			1.9				70.4			
			-3.7				78.9			
			0.6				72.5			
155	31	124	14.4	20.73	9.55	20.5	66.8	51.77	12.84	31.4
			13.9				52.3			
			20.2				35.4			
			34.4				52.6			

Table 12 (cont)

Whd temp cond (°F)	Round no.	Warhead no.	X Impact (meters)				Y Impact (meters)			
			X Axis	Mean	Std dev	Max spread	Y Axis	Mean	Std dev	Max spread
155	32	118	-175.2	-169.9	5.42	14.4	110.1	124.37	19.16	34.6
			-170.0				158.3			
			-164.4				115.6			
			-171.2				132.0			
			-166.7				118.8			
			-163.7				135.2			
			-178.1				100.6			
155	33	121	-6.8	-19.58	7.62	24.8	-48.8	-27.48	18.27	49.4
			-24.0				-50.5			
			-20.8				-21.9			
			-16.3				-35.0			
			-20.8				-21.9			
			-31.6				-13.2			
			-16.8				-1.1			
Amb	34	80	31.4	31.2	7.27	19.4	-88.8	-64.51	12.58	37.5
			40.0				-62.7			
			23.3				-57.5			
			20.6				-72.8			
			39.2				-61.3			
			32.1				-51.3			
			31.8				-57.2			
Amb	35	79	19.2	16.03	5.63	17.9	112.9	127.07	10.10	25.8
			15.9				132.4			
			4.9				134.4			
			22.8				129.3			
			14.2				113.4			
			18.6				128.4			
			16.6				138.7			
Amb	36	77	103.8	100.83	9.45	26.9	133.6	145.18	25.03	70.4
			114.2				106.0			
			106.2				148.7			
			94.1				166.4			
			87.3				176.4			
			99.4				140.0			
Amb	37	78	6.9	12.59	12.43	32.4	9.8	6.99	13.45	35.0
			-2.8				-12.8			
			-0.4				14.2			
			24.0				22.2			
			20.6				2.3			
			29.6				20.4			
			10.2				7.2			

Table 12 (cont)

Whd temp cond (°F)	Round no.	Warhead no.	X Impact (meters)				Y Impact (meters)			
			X Axis	Mean	Std dev	Max spread	Y Axis	Mean	Std dev	Max spread
Amb	39	81	-50.7	-45.34	7.02	17.7	81.0	83.38	12.19	32.9
			-53.9				85.2			
			-43.3				64.4			
			-42.6				97.3			
			-36.2				89.0			
Amb	40	84	5.7	3.47	8.68	22.8	74.4	71.66	18.92	47.2
			1.8				56.3			
			-7.3				57.4			
			8.6				88.0			
			9.9				44.7			
			-8.6				88.9			
			14.2				91.9			
Amb	41	83	52.0	45.77	8.61	22.2	127.4	138.55	15.54	41.8
			50.3				163.6			
			57.0				133.0			
			41.7				150.7			
			38.8				121.8			
			34.8				135.1			
Amb	42	82	-49.2	-42.55	18.41	48.7	-26.1	-36.60	9.70	22.8
			-34.4				-46.8			
			-38.1				-24.0			
			-76.8				-39.6			
			-29.7				-46.0			
			-28.1				-37.1			
155	43	122	-42.1	-43.51	8.04	2.57	-177.8	-174.79	13.11	39.2
			-34.9				-182.2			
			-60.6				-181.3			
			-37.4				-178.4			
			-43.0				-195.0			
			-48.4				-155.8			
			-42.9				-157.7			
			-38.8				-170.1			
-50	44	96	18.1	20.32	5.91	19.2	-33.9	-45.42	16.13	49.9
			16.1				-49.8			
			18.9				-22.8			
			17.1				-57.3			
			18.1				-40.1			
			20.8				-50.4			
			24.6				-55.7			
			15.0				-72.7			
			34.2				-26.1			

Table 12 (cont)

Whd temp cond (°F)	Round no.	Warhead no.	X Impact (meters) X Axis	X Mean	X Std dev	X Max spread	Y Impact (meters) Y Axis	Y Mean	Y Std dev	Y Max spread
-50	46	101	-38.9	-44.04	10.49	33.5	-62.6	-66.57	21.81	52.9
			-63.7				-55.2			
			-30.2				-94.0			
			-43.3				-56.8			
			-50.0				-48.1			
			-40.1				-101.0			
			-42.1				-48.3			
Date fired: 16 December 1980										
Nominal range: 1000 meters Line of fire: 22°										
Amb	61	90	6.1	0.28	6.98	15.9	-29.3	-14.78	31.42	68.8
			-3.5				-24.4			
			9.8				31.7			
			0.9				-37.1			
Amb	63	89	-58.2	-55.02	11.15	30.0	-48.2	-37.15	10.99	25.0
			-52.3				-27.9			
			-42.1				-45.1			
			-72.1				-41.4			
			-50.4				-23.2			
Amb	64	85	-31.2	-37.75	9.05	21.0	-28.8	-26.27	9.51	28.4
			-29.6				-30.3			
			-28.4				-38.3			
			-43.8				-22.5			
			-44.1				-27.8			
			-49.4				-9.9			
Amb	65	88	-43.4	-34.34	7.94	19.5	86.2	103.08	19.39	47.9
			-23.9				106.9			
			-32.4				87.7			
			-41.1				134.1			
			-30.9				100.5			
Amb	66	86	-41.3	-45.63	10.40	21.2	-33.6	-45.30	12.35	27.8
			-40.0				-48.2			
			-40.0				-61.4			
			-61.2				-38.0			

Table 13. Summary of results-time and position of airburst event

Warhead temp cond	-50°F	145°F	Ambient
Number of samples	18	19	17
Type motor (amb temp)	MK66	MK66	MK40
X-coordinate (m)			
Mean	-7.8	-15.9	+2.5
Maximum	37	13	34
Minimum	-46	-41	-28
Std dev	21.2	17.5	17.4
Y-coordinate (m)			
Mean	746.2	959.6	801.5
Maximum	1045	1186	953
Minimum	577	819	626
Std dev	113.9	117.1	73.8
Z-coordinate (m)			
Mean	307.2	384.3	269.2
Maximum	445	475	299
Minimum	235	304	197
Std dev	52.3	57.4	27.4
Event time (sec)			
Mean	2.02	2.42	2.60
Maximum	2.68	2.91	2.81
Minimum	1.74	2.06	2.17
Std dev	0.25	0.25	0.17

NOTE

Y axis is along the line-of-fire in meters from the launcher. X axis is perpendicular to the line-of-fire, positive to the right. Z axis is height above the launcher.

Table 14. Round-by-round function on arming data

Rocket no	Function distance (ft)	Function time* (sec)	Remarks
Conditioning temperature (°C):		68	Quadrant elevation (mils): 89
A1	595	0.749	
A2	595	0.760	
A3	620	0.775	
A4	593	0.758	
A5	N	N	No test - no function
A6	N	N	No test - no function
A7	N	N	No test - no function
A8	550	0.735	
A9	595	0.755	
A10	542	0.726	
A11	535	0.718	
A12	564	0.742	
A13	633	0.776	
A14	595	0.761	
A15	602	0.761	
A16	N	N	No test - no function
A17	N	N	No test - no function
A18	556	0.722	
A19	564	0.727	
A20	N	N	No test - no function
A21	615	0.777	
A22	579	0.748	
A23	N	N	No test - no function
A24	N		No test - no function
A25	544	0.731	
A26	513	0.707	
A27	508	0.693	
A28	540	0.727	
A29	591	0.758	
A30	591	0.766	
A31	M	0.999	Functioned long
A32	610	0.774	
A33	554	0.720	
A34	622	0.776	
A35	539	0.724	

Table 14 (cont)

Rocket no	Function distance (ft)	Function time* (sec)	Remarks
Conditioning temperature (C°):		22	
A36	539	0.751	
A37	522	0.75	
A38	N	N	No test - no function
A39	N	1.260	Functioned long
A40	500	0.726	
A41	M	1.16	Functioned long
A42	564	0.765	
A43	N	N	No test - no function
A44	583	0.786	
A45	N	N	No test - no function
A46	559	0.750	
A47	N	N	No test - no function
A48	M	1.09	Functioned long
A49	N	N	No test - no function
A50	M	M	Functioned long
A51	556	0.762	
A52	518	0.75	
A53	N	N	No test - no function
A54	N	N	No test - no function
A55	525	0.726	
A56	550	0.756	
A57	1089	1.046	Functioned long
A58	N	N	No test - no function
A59	531	0.736	
A60	519	0.736	
A61	M	1.216	Functioned long
A62	516	0.726	
A63	N	N	No test - no function
A64	529	0.737	
A65	576	0.770	
A66	N	N	No test - no function
A67	522	0.745	
A68	583	0.78	
A69	542	0.746	
Conditioning temperature (°C):		-48	
A70	N	N	No test; low launch angle
A71	N	N	No test; low launch angle
Quadrant elevation (mils): 106			
A72	600	0.842	

Table 14 (cont)

Rocket no	Function distance (ft)	Function time* (sec)	Remarks
Conditioning temperature (C°):		22	
Quadrant elevation (mils): 120			
A73	592	0.856	
A74	580	0.85	
A75	568	0.813	
A76	N	N	No test - no function
A77	666	0.909	
A78	N	N	No test - no function
A79	642	0.858	
A80	N	N	No test - no function
A81			
A82			
A83	N	N	No test - no function
A84	684	0.93	
A85	N	N	No test - no function
A86	N	N	No test - no function
A87	624	0.88	
A88	N	N	No test - no function
A89	529	0.799	
A90	N	N	No test - no function
A91	677	0.893	
A92	619	0.867	
A93	N	N	No test - no function
A94	869	1.047	
A95	N	N	No test - no function
A96	N	N	No test - no function
A97	1160	1.20	Functioned long
A98	N	N	No test - no function
A99	N	N	Rocket damaged, not launched
A100	642	8.876	
A101	604	0.854	
A102	524	0.800	
A103	580	M	
A104	N	N	No test - no function

LEGEND: M - Missing
N - No data applicable

*Times expressed within a millisecond were obtained from the primary data source (IR chronograph). Times expressed within one hundredth of a second were obtained from the backup data source (video).

Table 15. Round -by-round fuze functioning data

Rocket no	Cond temp (°C)	Fuze pretest envir	Fuze set time (sec)	Fuze func time* (Sec)	Remarks
SV1	22	None	2.0	1.987	Spotter
SV2	|	|	2.0	1.94	|
SV3	|	|	11.850	11.928	|
SV4	|	|	11.850	11.962	|
SV5	|	|	20.275	20.440	|
SV6	22	None	20.275	20.375	Spotter
V1	68	Hel vibr	2.0	1.907	
V2	68	|	11.850	12.303	
V3	68	|	20.275	21.053	
V4	22	|	2.0	1.972	
V5	|	|	11.850	11.964	
V6	|	|	11.850	11.953	
V7	22	|	20.275	20.487	
V8	-48	Hel vibr	2.0	1.966	
V9	|	|	2.0	1.961	
V10	|	|	2.0	1.949	
V11	|	|	11.850	11.899	
V12	|	|	11.850	11.857	
V13	|	|	11.850	11.487	
V14	|	|	20.275	21.072	
V15	|	|		20.429	
V16	|	|		20.483	
V17	-48	Hel vibr	20.275	21.486	
V18	68	Temp shock	2.0	1.946	
V19	68	|	**N	**N	
V20	68	|	20.275	21.101	
V21	22	|	2.0	1.944	
V22		|	11.850	12.067	
V23		|	11.850	12.065	
V24	22	|	20.275	20.557	
V25	-48	Temp shock	2.0	1.932	
V26	|	|	2.0	1.907	
V27	|	|	2.0	2.351	
V28	|	|	11.850	11.842	
V29	|	|	11.850	12.147	
V30	|	|	11.850	11.905	
V31	-48	Temp shock	20.275	20.308	
V32	|	|		20.455	
V33	|	|		20.395	
V34	-48	Temp shock	20.275	20.324	
V35	68	Control	2.0	1.945	
V36	68	|	11.850	11.989	
V37	68	|	20.275	20.916	
V38	22	|	2.0	1.943	
V39	22	|	11.850	11.983	
V40	22	|	20.275	20.497	
V41	-48	Control	2.0	1.923	

Table 15. (cont)

Rocket no	Cond temp (°C)	Fuze pretest envir	Fuze set time (sec)	Fuze func time* (Sec)	Remarks
V42	-48	Control	2.0	1.936	
V43			2.0	1.972	
V44			11.850	12.138	
V45			11.850	12.988	
V46			11.850	11.852	
V47			20.275	20.362	
V48				20.412	
V49				20.236	
V50	-48	Control	20.275	20.305	

LEGEND: Hel vibr - Helicopter vibration
M - Missing
N - No Data

*Times expressed within a millisecond were obtained from the primary data source (IR chronograph). Times expressed within one hundredth of a second were obtained from the backup data source (video).

**Test rocket V19 was inadvertently dropped in handling, damaging the umbilical. It was decided not to fire this round as a safety precaution.

Table 16. Round-by-round fuze performance, low temperature

Rd no	Vel at MBO (fps)	Vel at fuze function (fps)	Time to warhead function (sec)	No. SM function	No. SM duds	No. SM lost	Remarks
Temperature conditioned (°C): -46 Range to target (m): 1000							Fuze set time (sec): 1.6 Launch elevation (mils): 434
F1	1863	1746	1.81	7	2	1	No. 3 not armed, No. 7 armed no trigger
F2	1863	1824	1.40	9	0	0	
F3	1882	1842	1.36	8	0	1	
F4	1863	1843	1.28	6	1	2	No. 7 partially armed, no data on No. 9
Range to target (m) 3000 Launch elevation (mils): 245							Fuze set time (sec): 6.1
F5	1882	M	M	9	0	0	
F6	M	M	M	9	0	0	
F7	1902	M	M	8	1	0	No. 8 armed, no trigger
F8	1882	1078	6.82	8	1	0	No. 4 no shear, not armed
F9	1863	1078	6.87	9	0	0	
F10	1882	1098	6.79	9	0	0	
F11	1882	1078	6.86	7	1	1	No. 3 air collision, slider crimped shut
F12	1882	1059	7.37	9	0	0	
F13	1882	1098	6.78	8	1	0	No. 4 not armed, impact tree
F14	1863	1059	6.98	9	0	0	
F15	1902	1098	7.17	9	0	0	
F16	1882	1098	6.72	9	0	0	
F17	1898	1098	6.62	9	0	0	
F18	1918	1098	6.65	9	0	0	
F19	1863	1059	7.14	9	0	0	
F20	1882	1039	7.71	9	0	0	
F21	1898	1078	6.89	8	0	1	
F22	1890	1090	6.73	9	0	0	

Table 16 concluded.

Rd no	Vel at MBO (fps)	Vel at fuze function (fps)	Time to warhead function (sec)	No. SM function	No. SM duds	No. SM lost	Remarks
Range to target (m): 6000 Launch elevation (mils): 327							Fuze set time (sec): 18.0
F23	1922	588	21.06	8	1	0	No. 7 armed, no trigger
F24	1922	588	19.97	9	0	0	
F25	1902	588	22.19	8	1	0	No. 2 not armed
F26	1922	628	18.47	9	0	0	
F27	1902	628	19.36	9	0	0	
F28	1918	628	18.74	8	1	0	No. 3 armed, no trigger, impact
F29	1918	628	18.51	8	1	0	No. 6 not armed
F30	1918	620	18.95	9	0	0	
F31	1914	647	18.95	8	1	0	No. 9 not armed
F32	1922	628	19.05	9	0	0	
F33	1922	628	18.91	8	1	0	No. 1 not armed
F34	1922	628	18.84	9	0	0	
F35	1922	628	18.86	9	0	0	
F36	1922	628	18.14	9	0	0	
F37	1902	635	18.79	9	0	0	
F38	1922	628	19.01	9	0	0	
F39	1914	608	19.84	9	0	0	
F40	1922	600	20.16	9	0	0	
			Totals	342	13	5	Point estimate of reliability 0.962

LEGEND: M - Missing data
MBO - Motor burn out
N - No data applicable

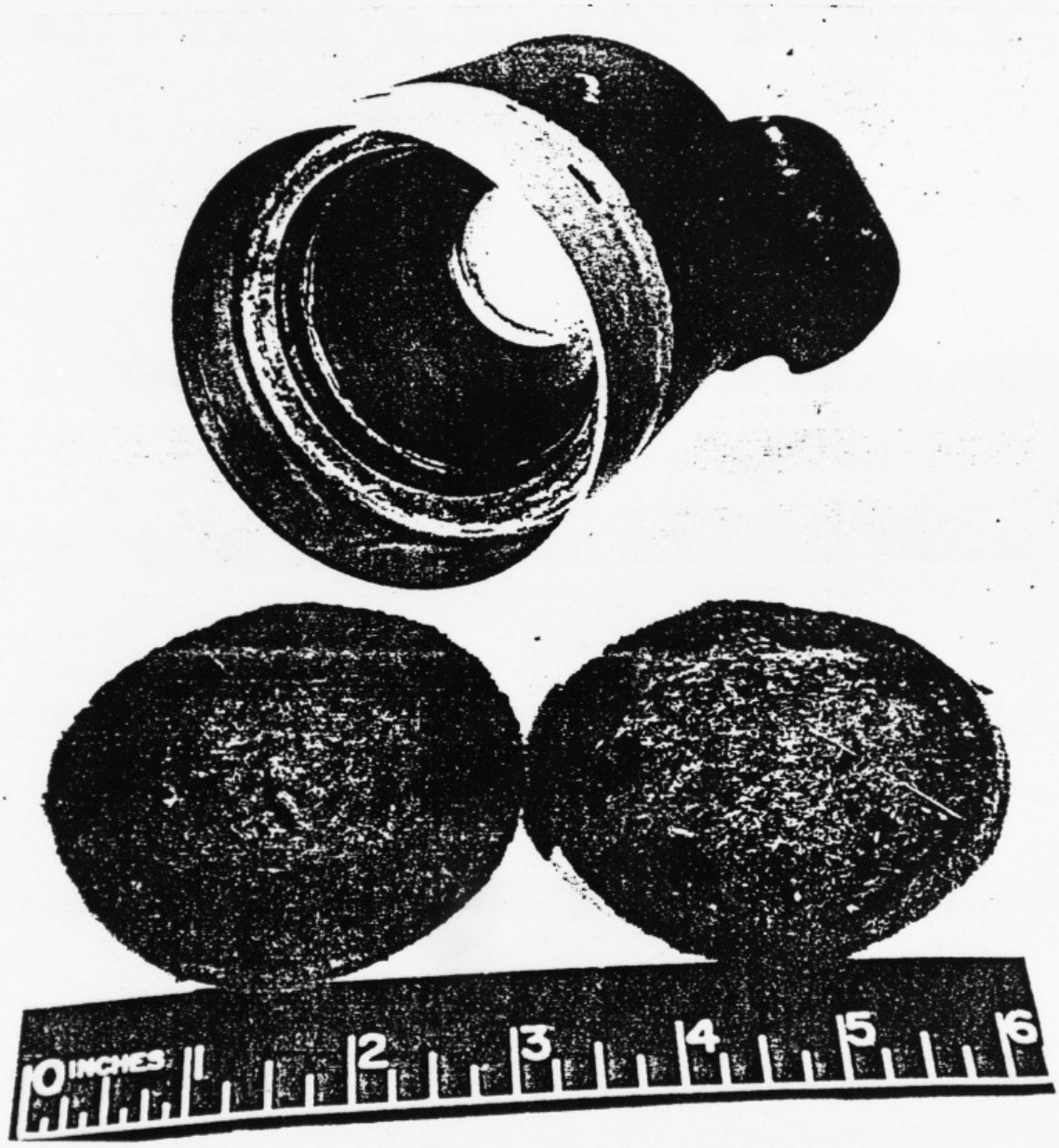

Figure 1. Copper cones scored by rotation RAD assembly (top); felt pad crushed (bottom)

Figure 2. Pushed in metal end cap of cover tube

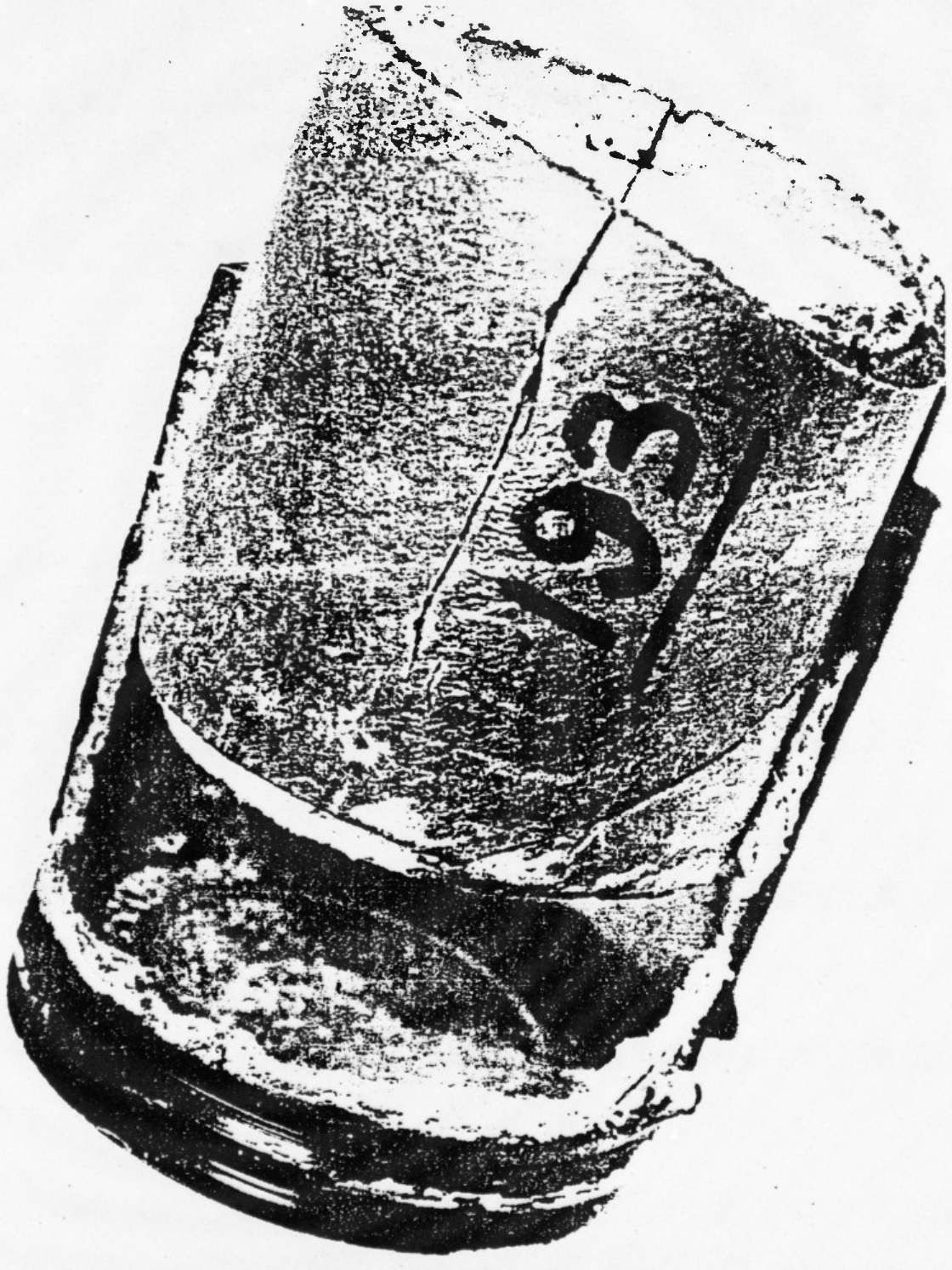

Figure 3. Cushion of nose cushion assembly compressed 1/4 inch

Figure 4. 1-inch neck ring signature on rocket motor case assembly showing longitudinal movement within the M67 fiber container

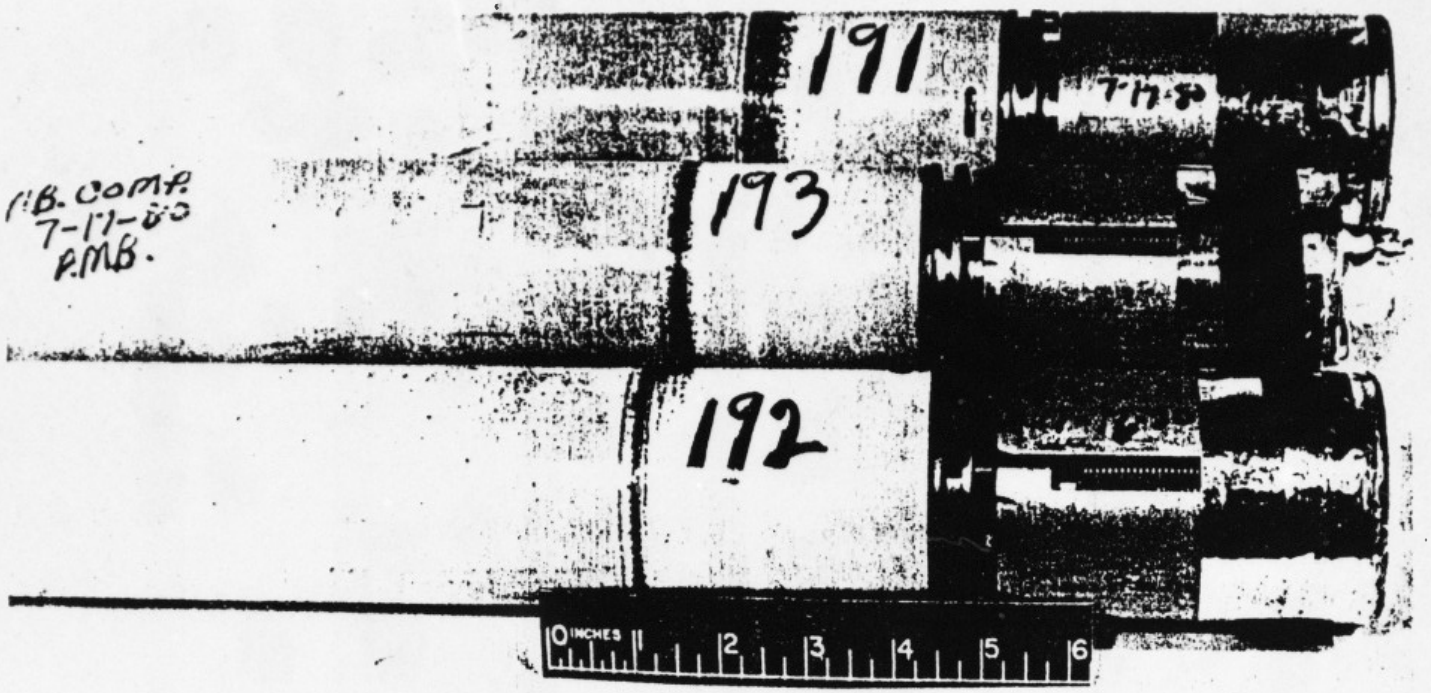

Figure 5. 1/8 to 1/4-inch neck ring signature on rocket motor case assembly showing longitudinal movement within the M67 fiber container

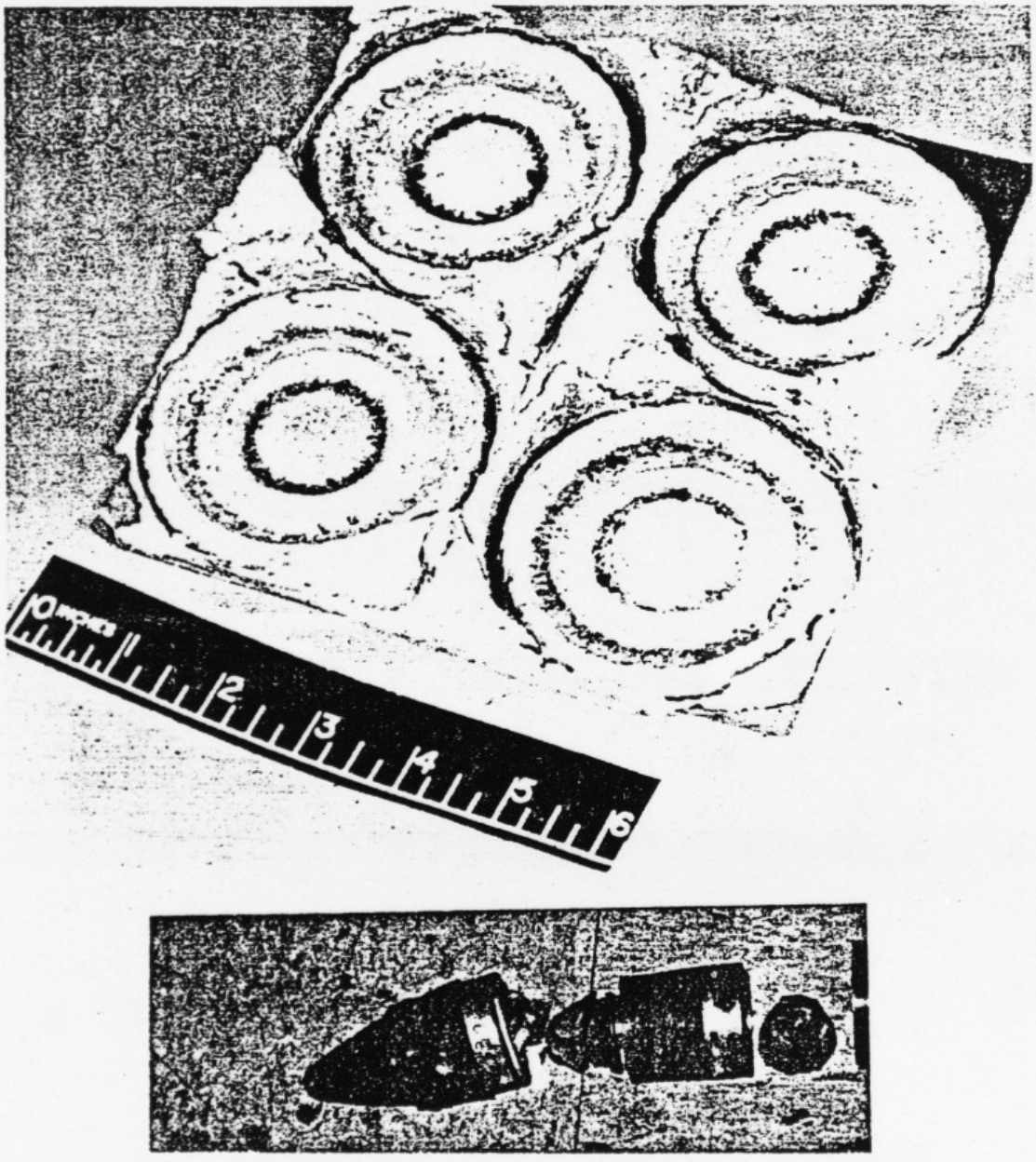

Figure 6. Motor end packaging crushed (top). Nose cone assembly (rd 194) completely separated from warhead assembly (bottom)

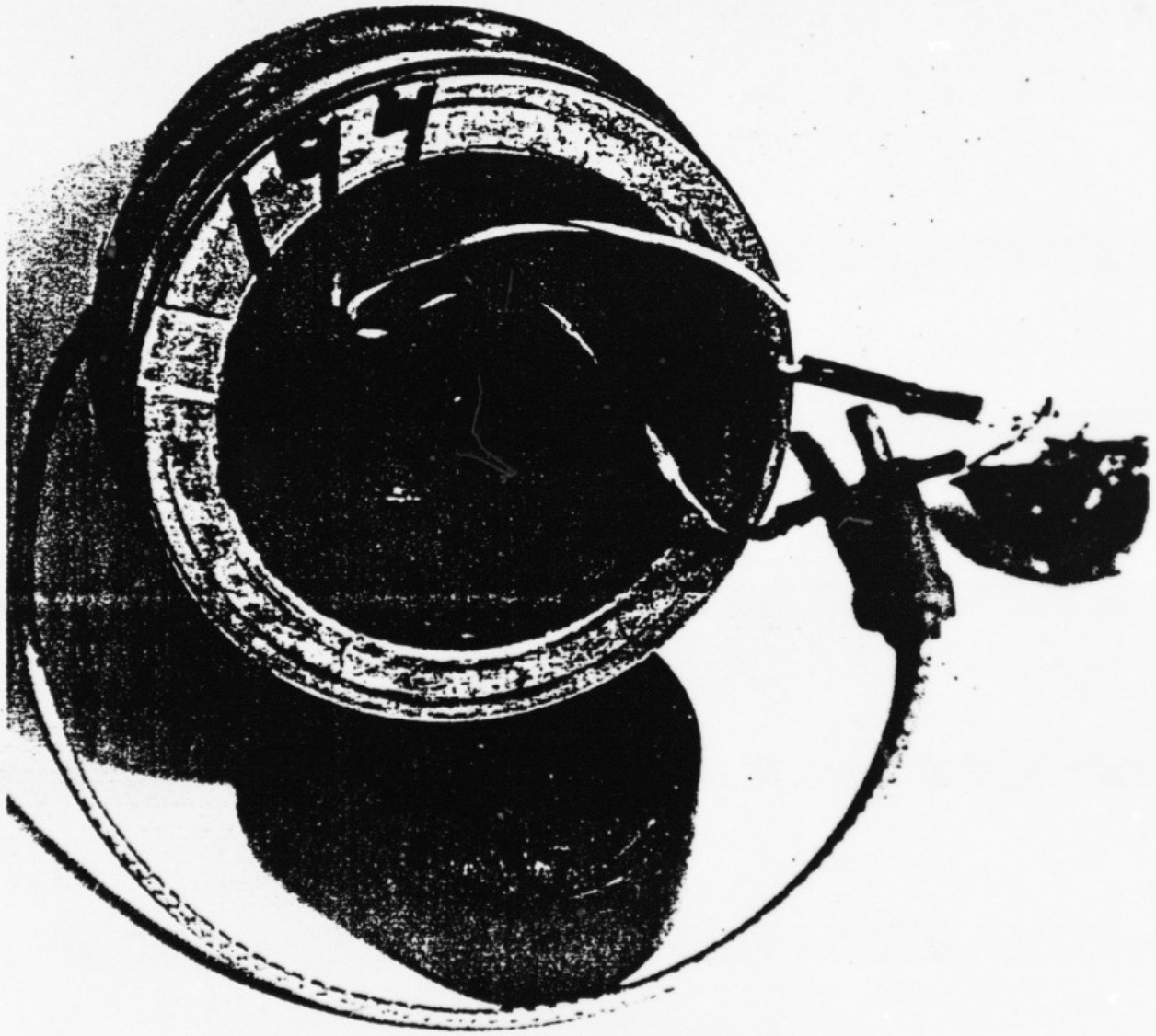

Figure 7. Fuze connector cable sheared on edge of nose-cone assembly

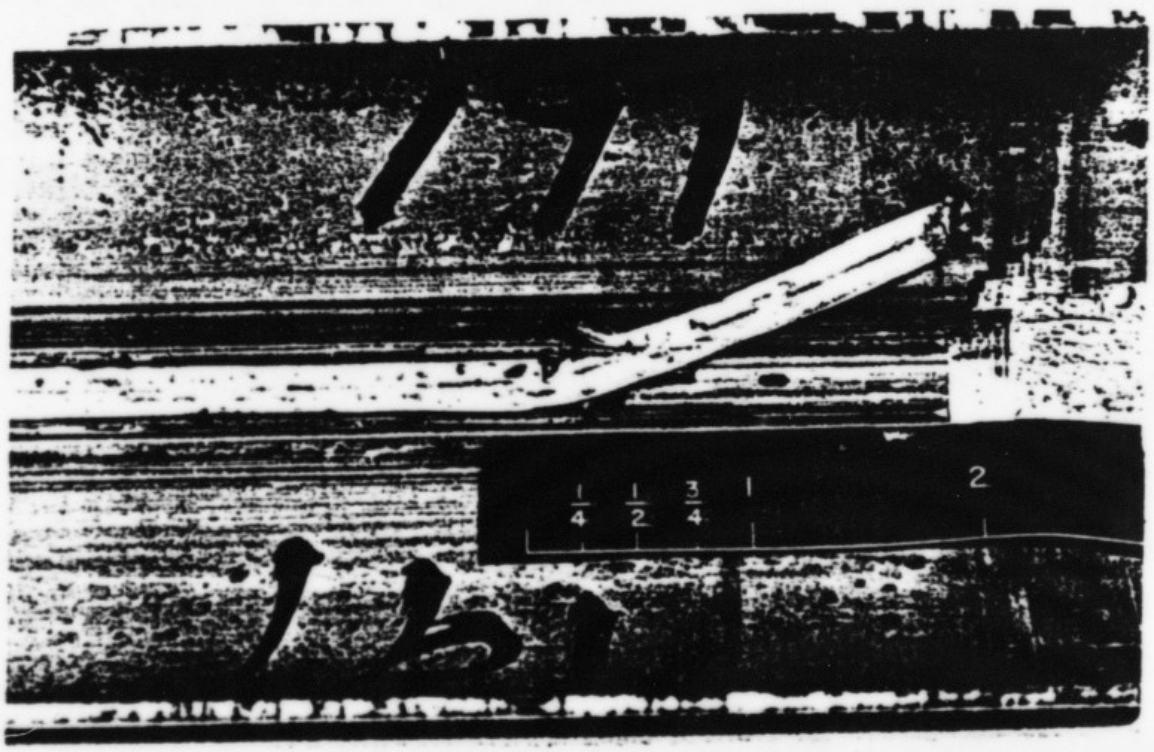

Figure 8. Fuze connector cable cut at mouth of warhead case assembly

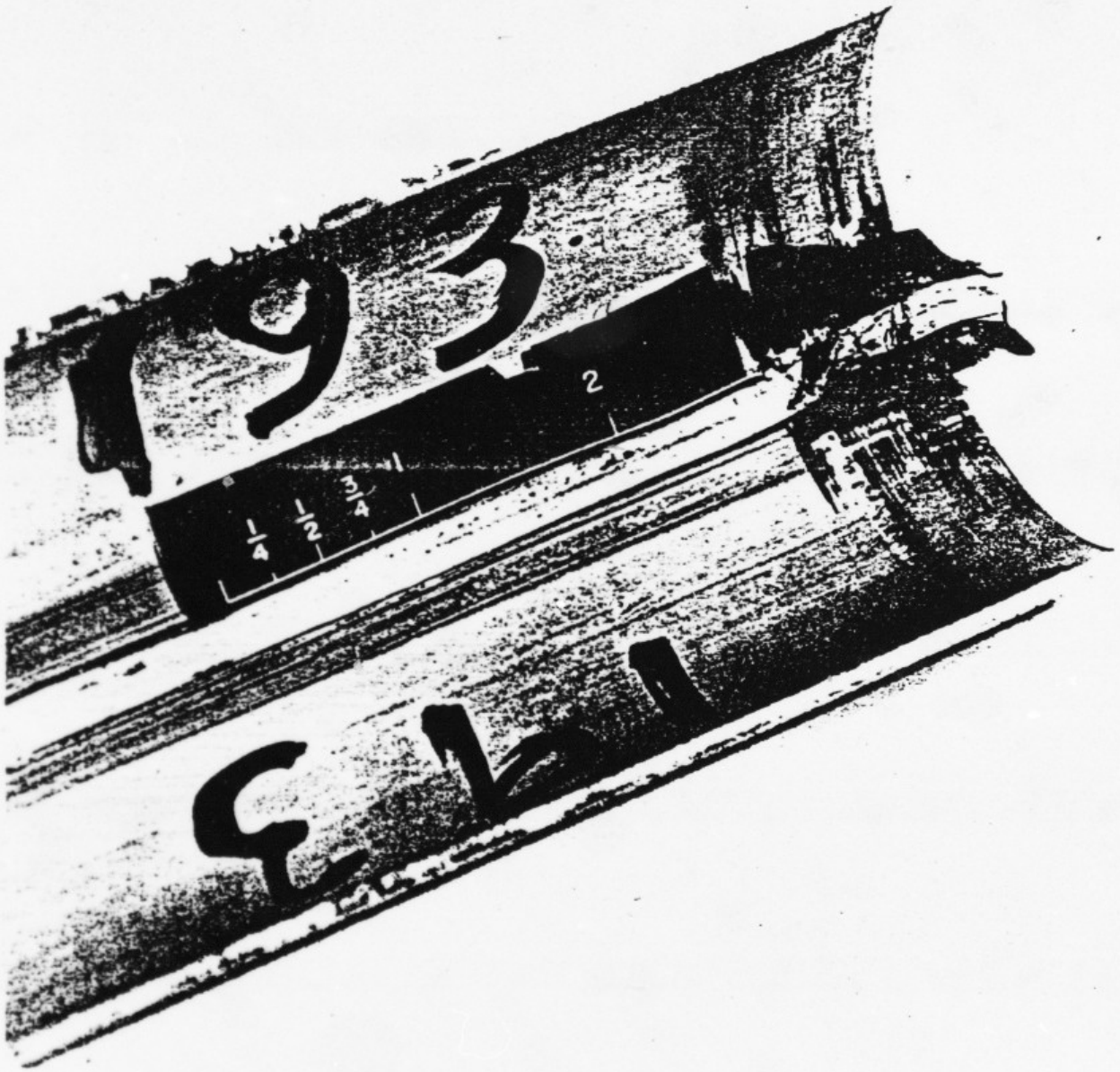

Figure 9. Fuze connector cable cut at mouth of warhead case assembly

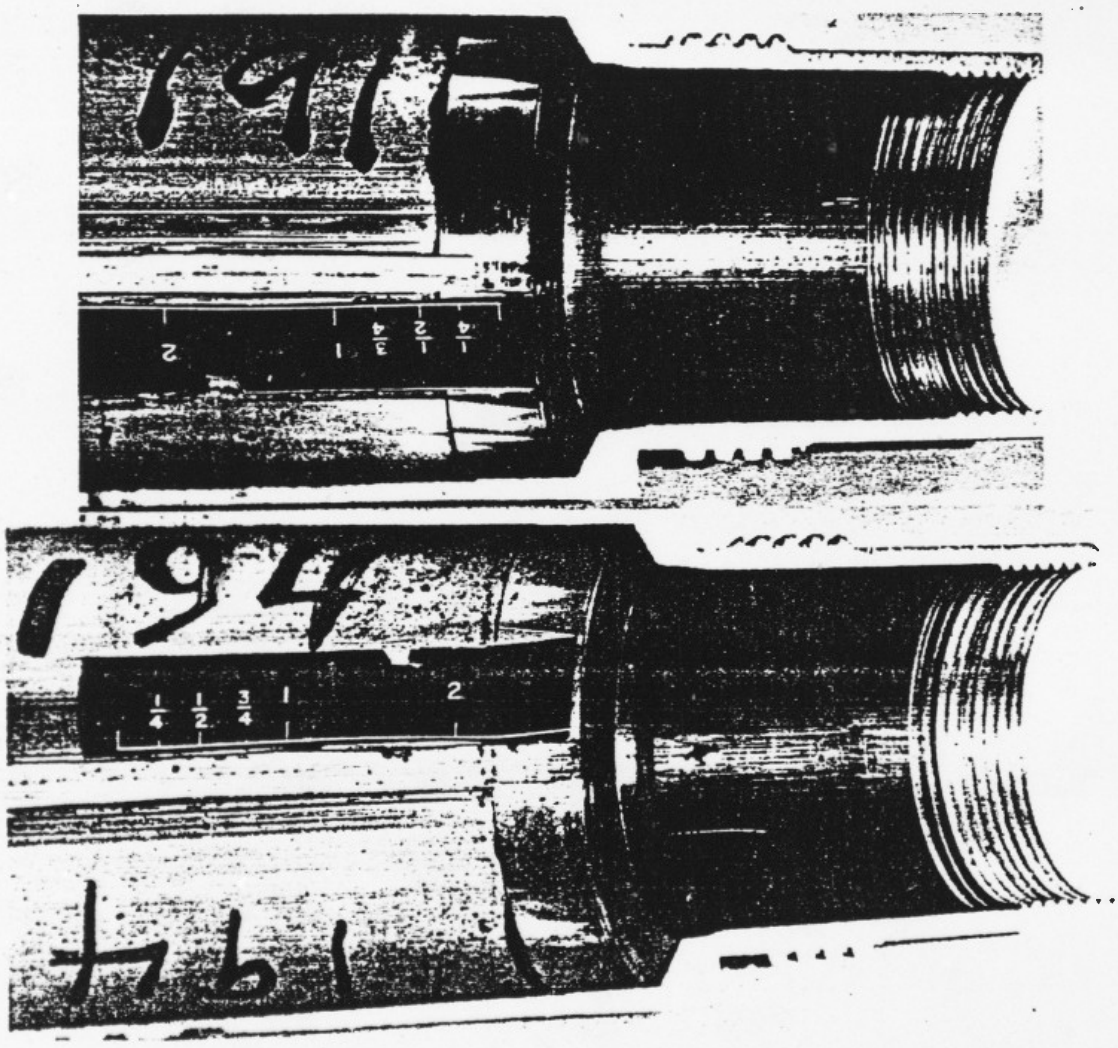

Figure 10. Fuze connector cable severed at fuze support

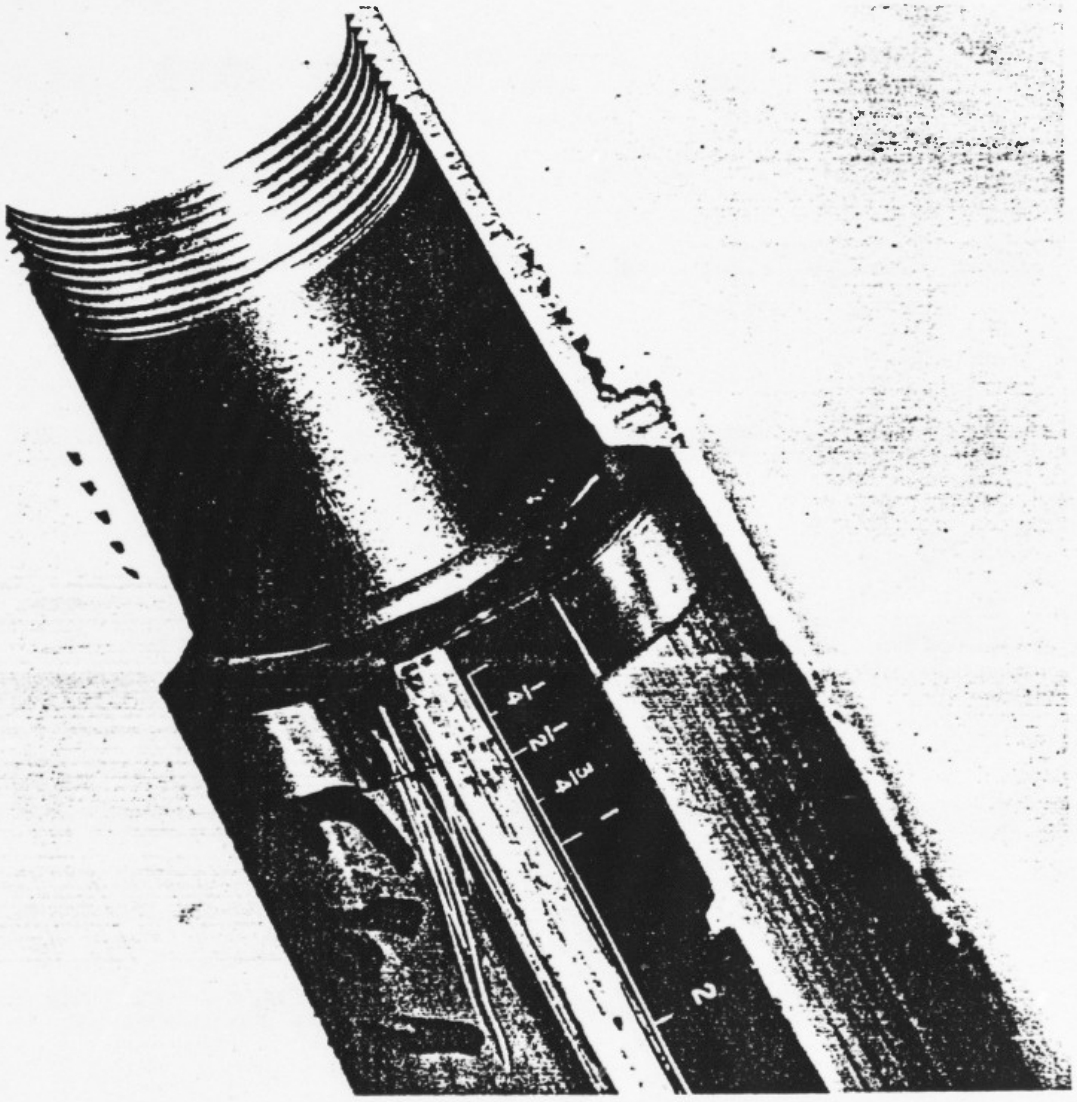

Figure 11. Fuze connector cable severed at fuze support

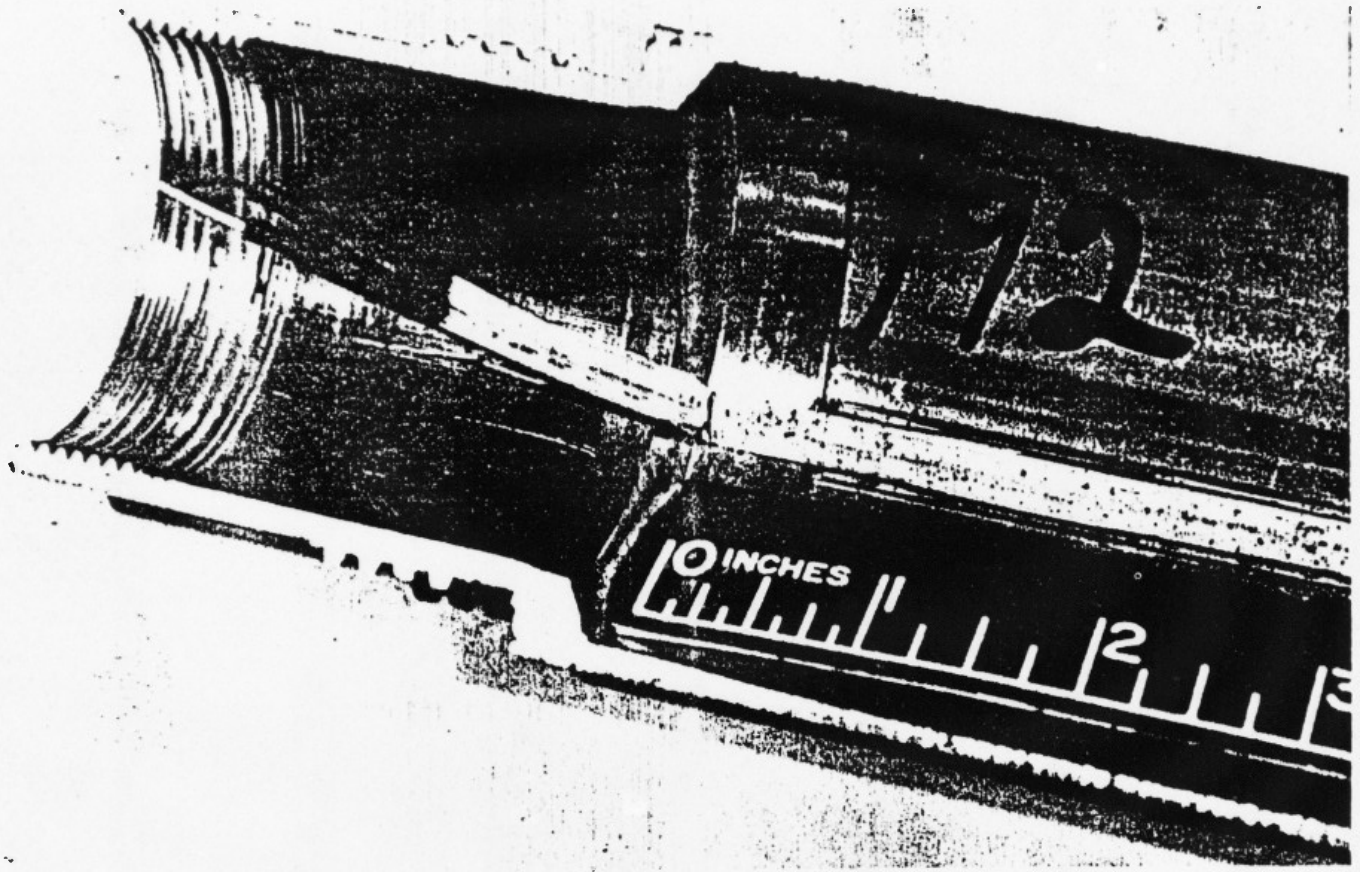

Figure 12. Fuze connector cable partially severed at fuze support

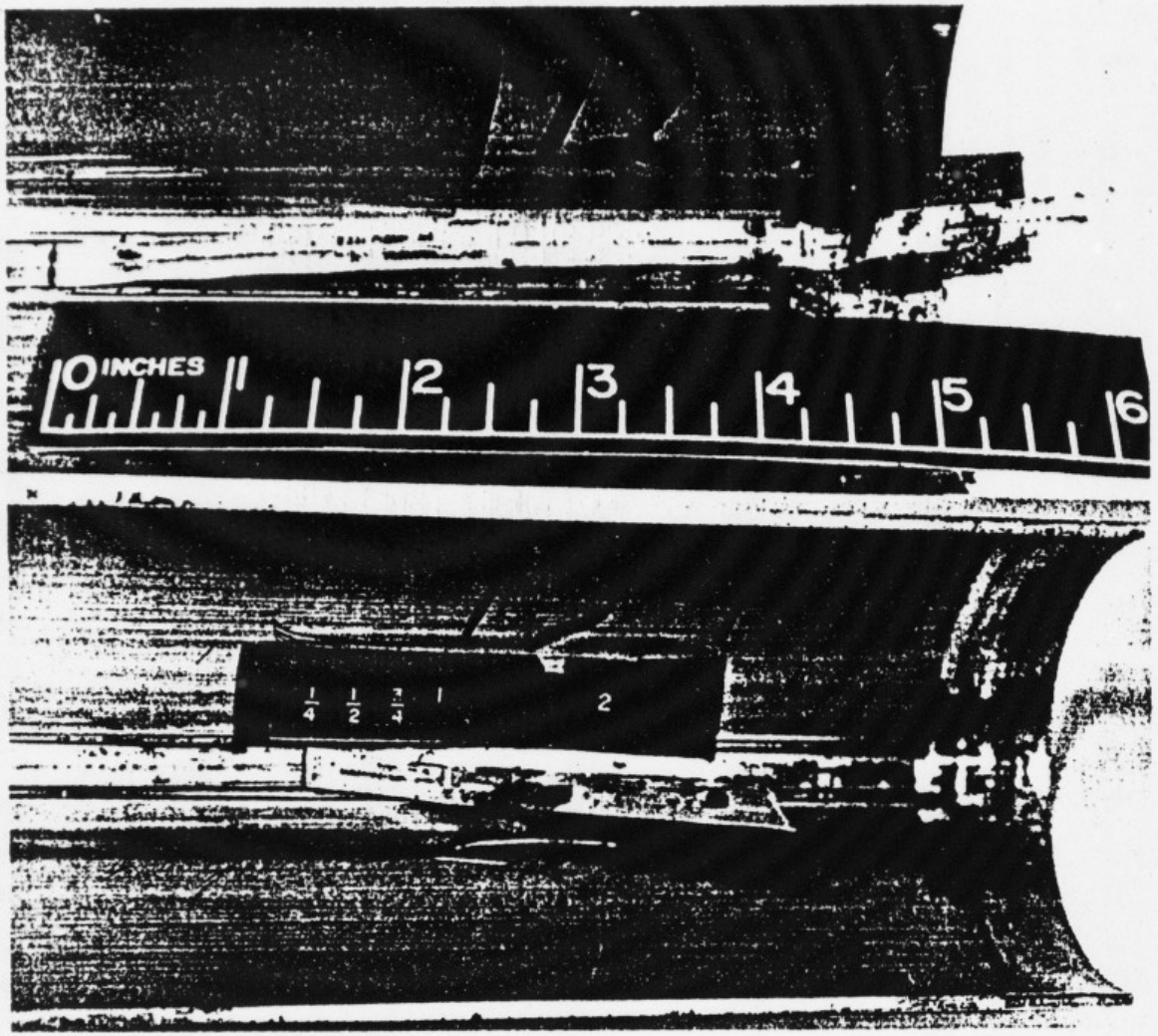

Figure 13. Fuze connector cable pulled out of connector cable groove

Figure 14. Firing pin stake failed

Figure 15. Rd. No. 212. Warhead case pins or rivets sheared and elongated the pinholes in the warhead case assembly after nose down and 45° to nose drops.

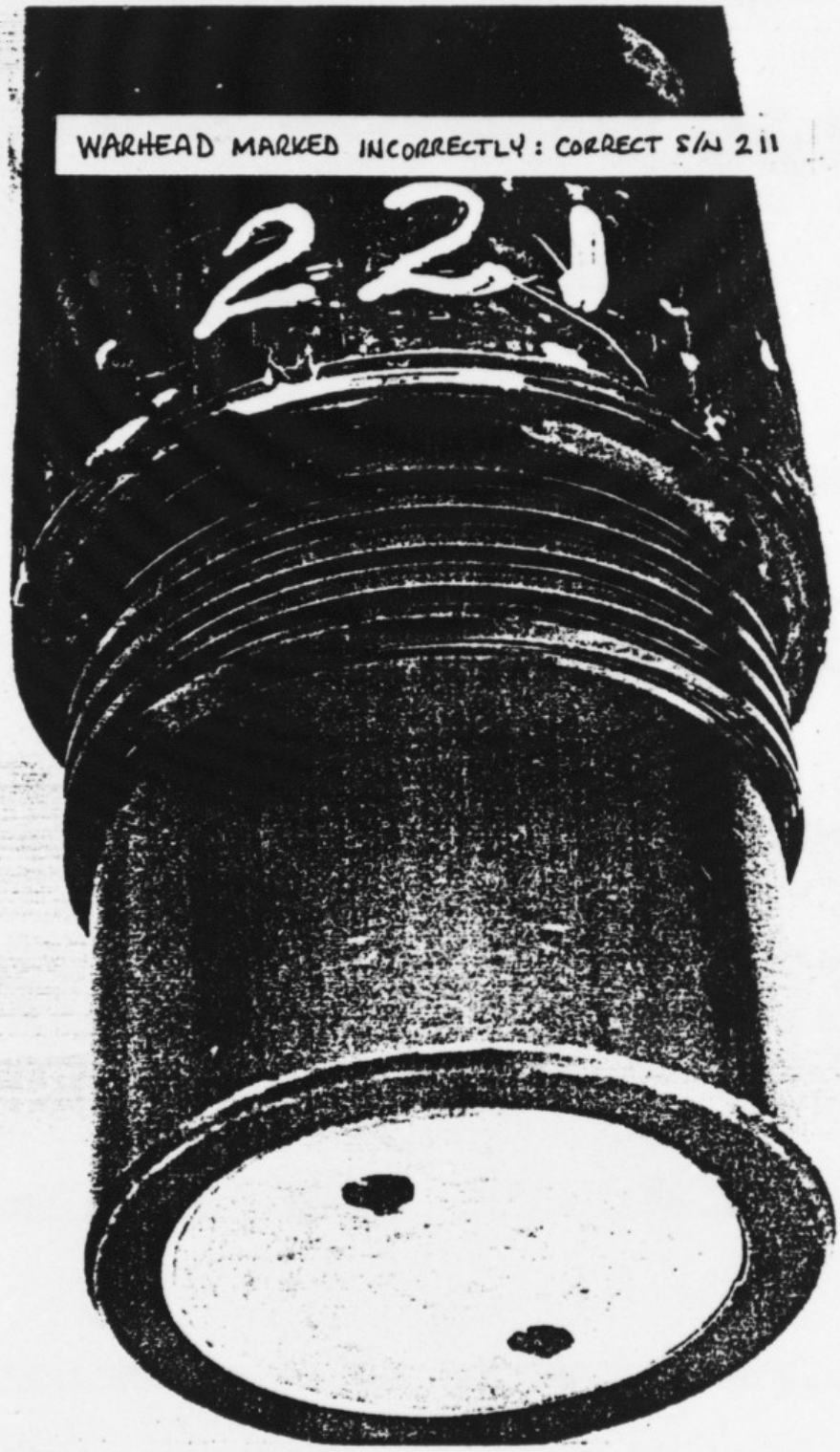

Figure 16. Rd. No. 211 Warhead case pins or rivets sheared and elongated the pinholes in the warhead case assembly after the nose down and 45° to nose drops

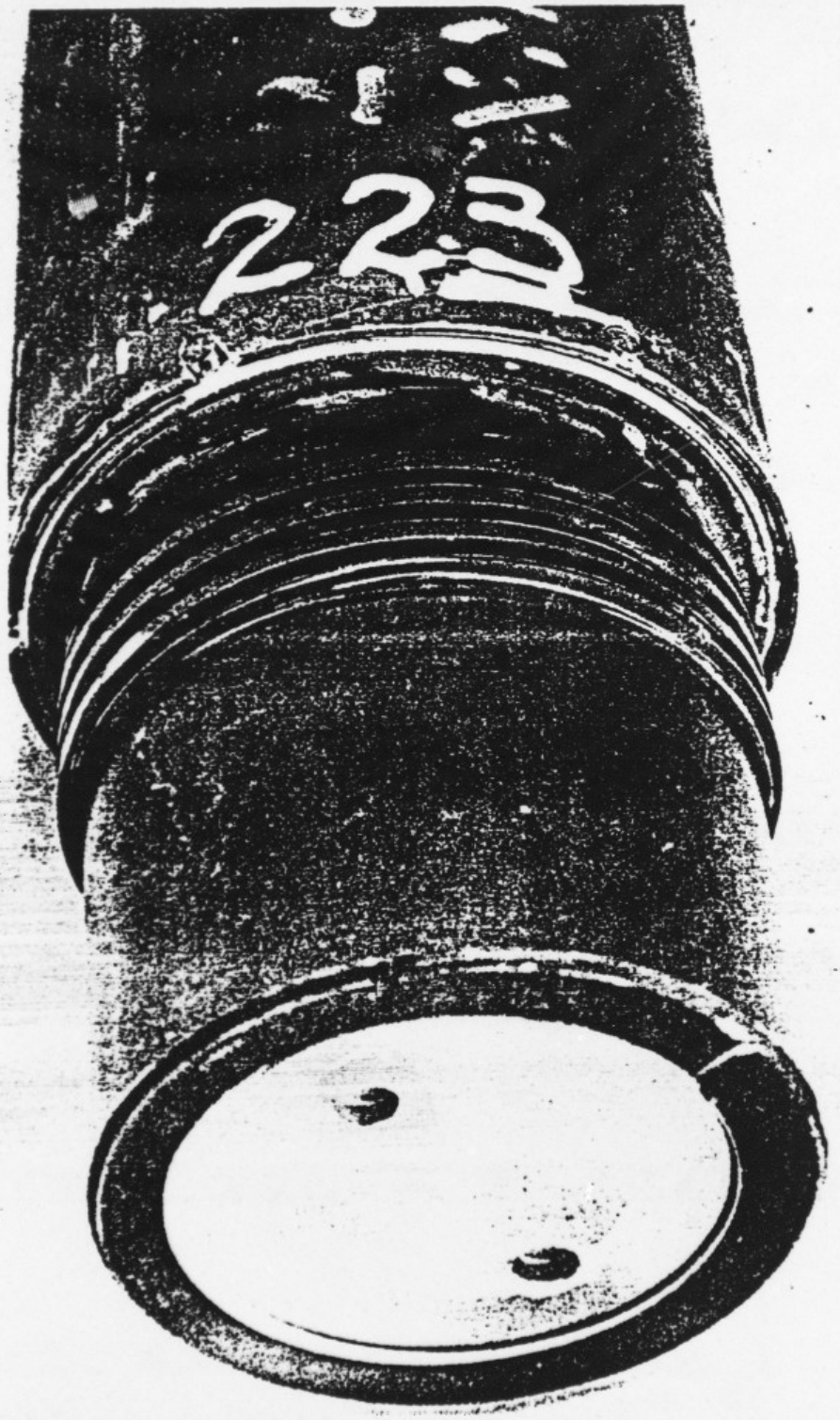

Figure 17. Rd. No. 223. Warhead case pins or rivets sheared and elongated the pinholes in the warhead case assembly after 45° to nose and 45° to base drops.

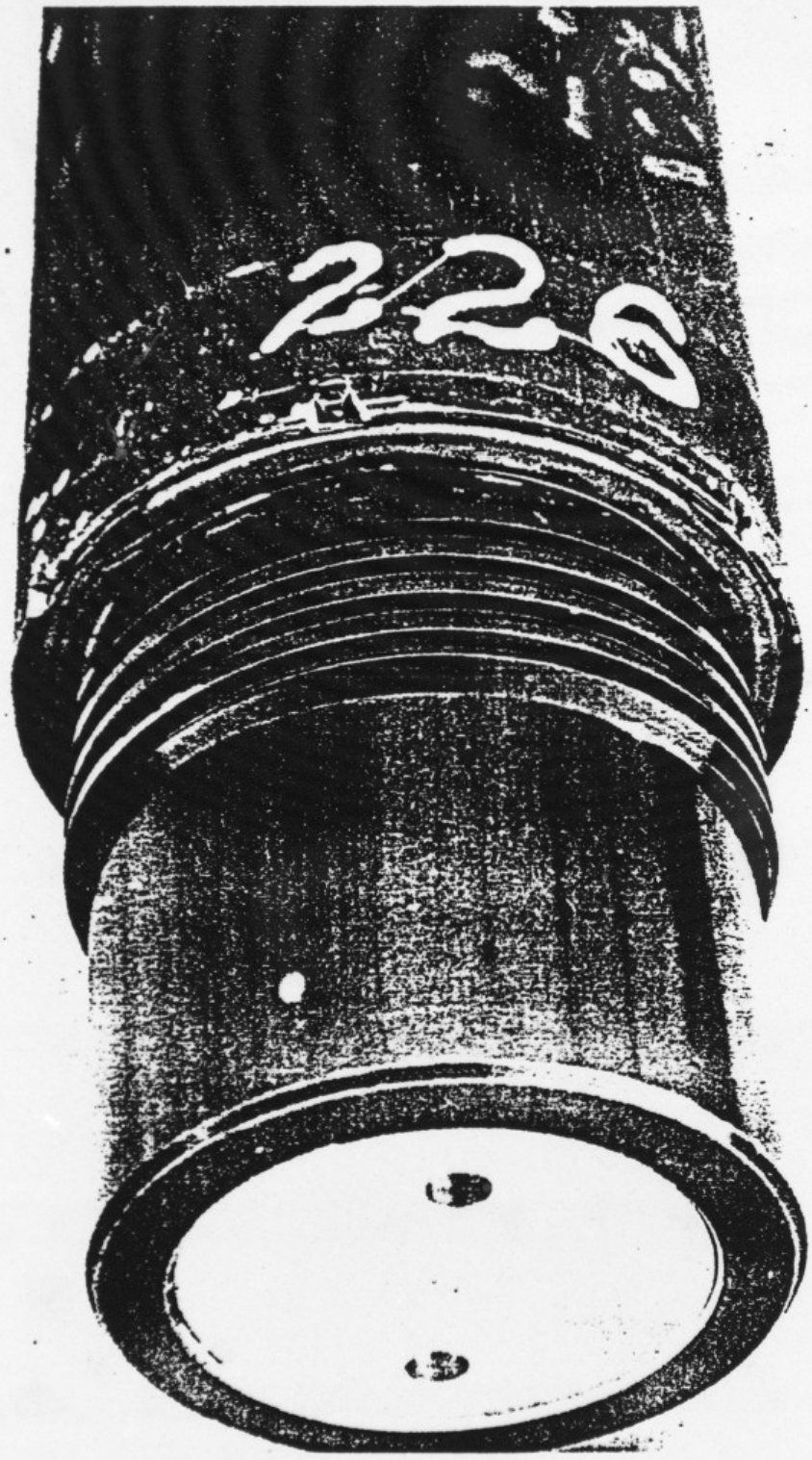

Figure 18. Rd. No. 226. Warhead case pins or rivets sheared and elongated the pinholes in the warhead case assembly after 45° to nose and 45° to base drops.

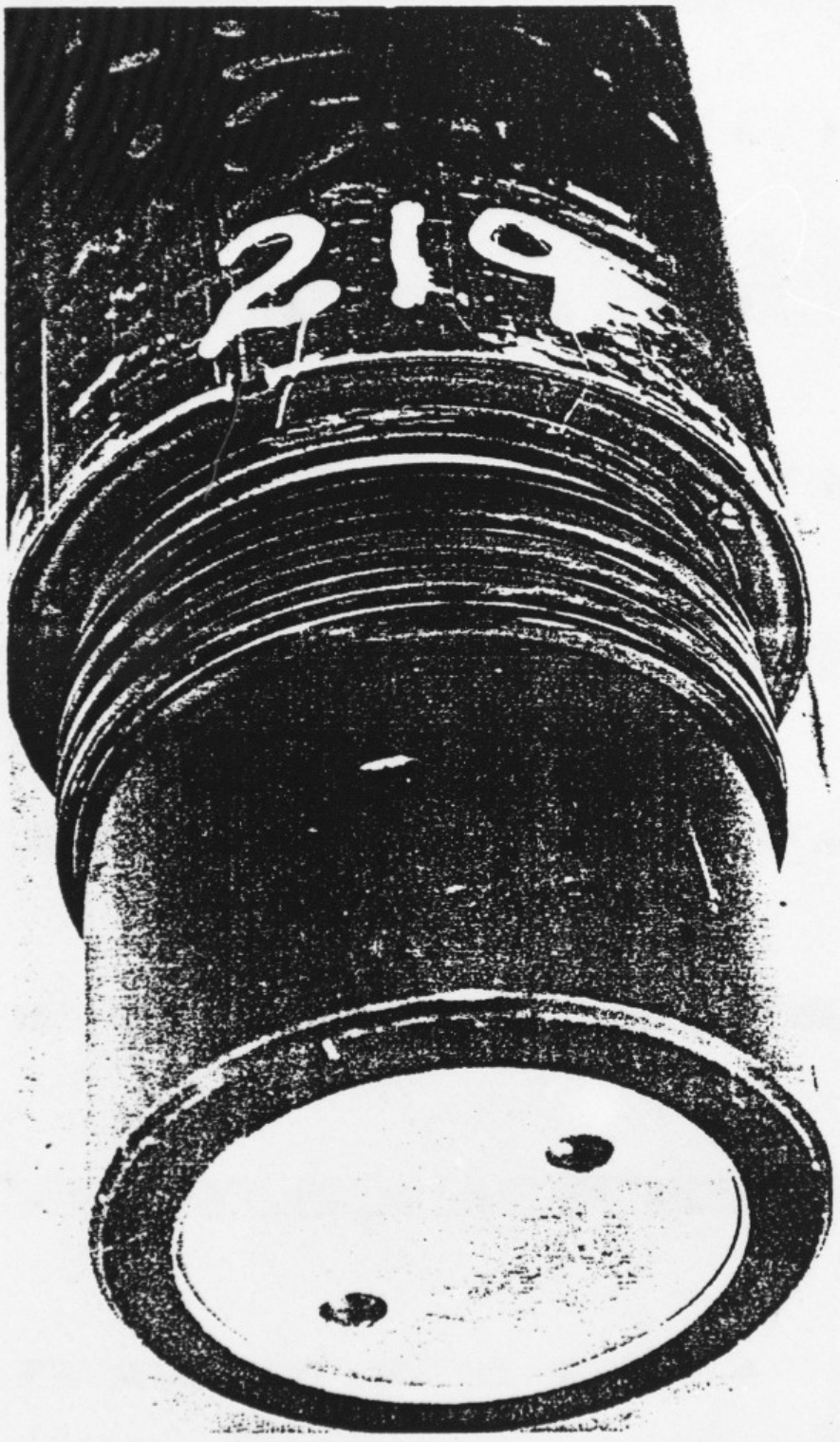

Figure 19. Rd. No. 219. Warhead case pins or rivets sheared and elongated the pinholes in the warhead case assembly after the base down and 45° to nose drops.

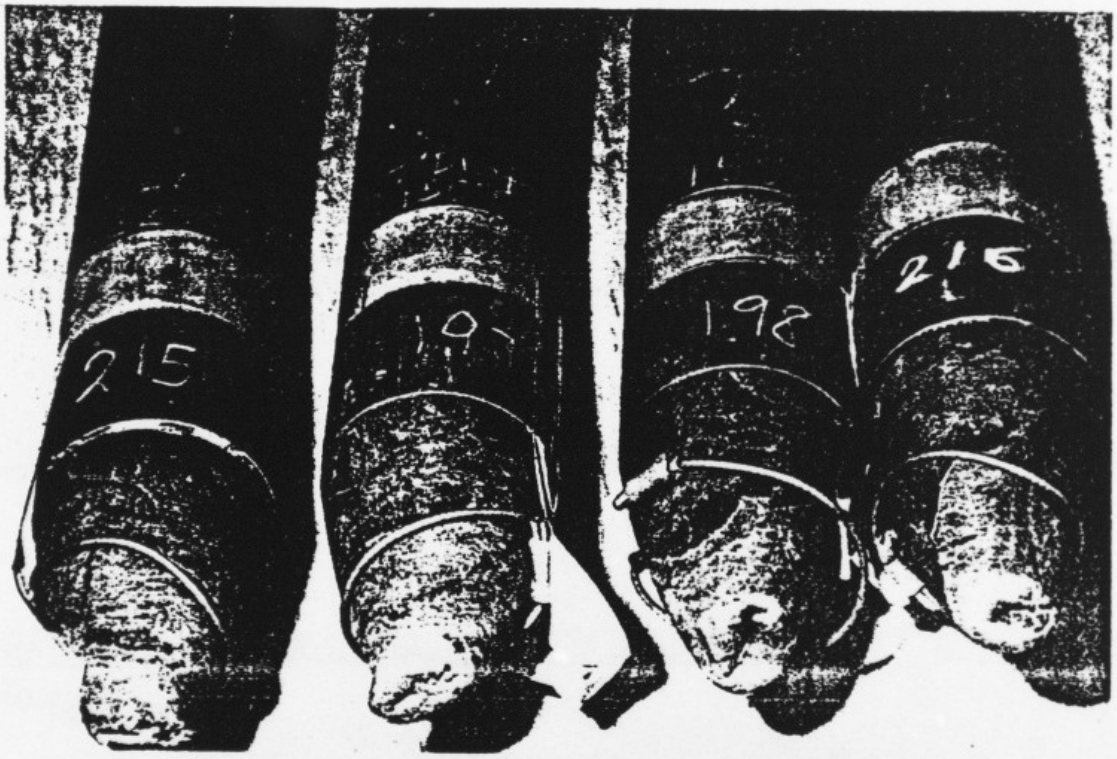

Figure 20. Box 2, 150°F, rd. No. 197, 198, 215, 216. Nose cone assembly (PN9334119), ARRADCOM Dwg. No. 9334097, flattened 7/8 to 1 inch after nose down and 45° to base drops.

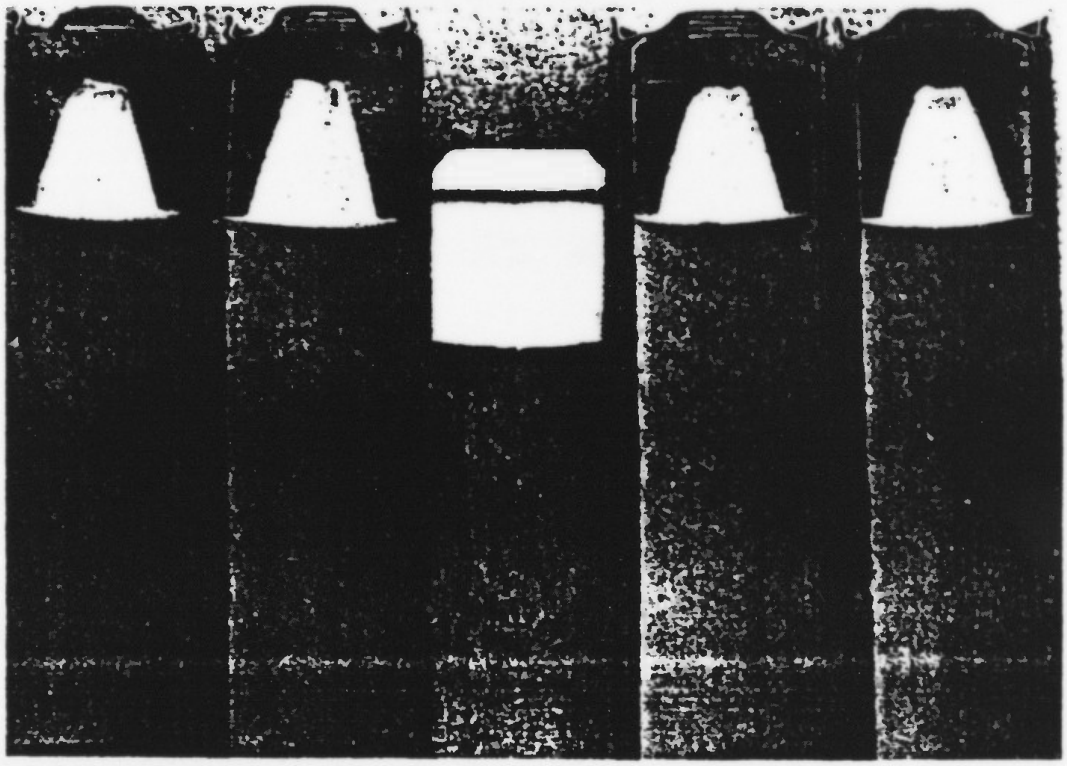

Figure 21. Box 2, 150°F, rd. No. 197, 198, 215, 216. Nose cushion assembly, ARRADCOM Dwg. No. SK-JM-4, crushed on nose down drop, causing nose cone assembly to be flattened to the same geometry as the nose cushion assembly.

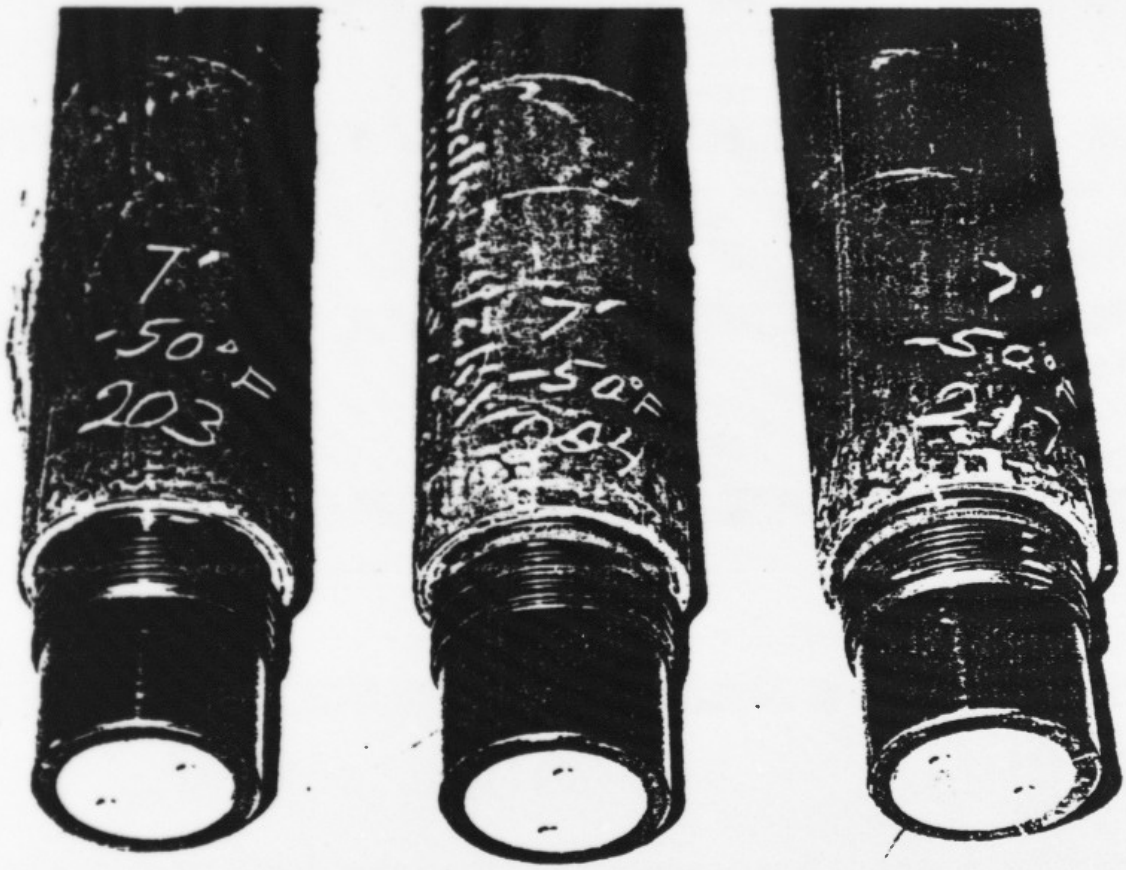

Figure 22. Box 4, -50°F, rd. No. 203, 204, 217. Warhead case pins or rivets sheared and/or elongated the pinholes in the warhead case assembly (PN 9334131) after the base (motor end) and 45° to nose drops.

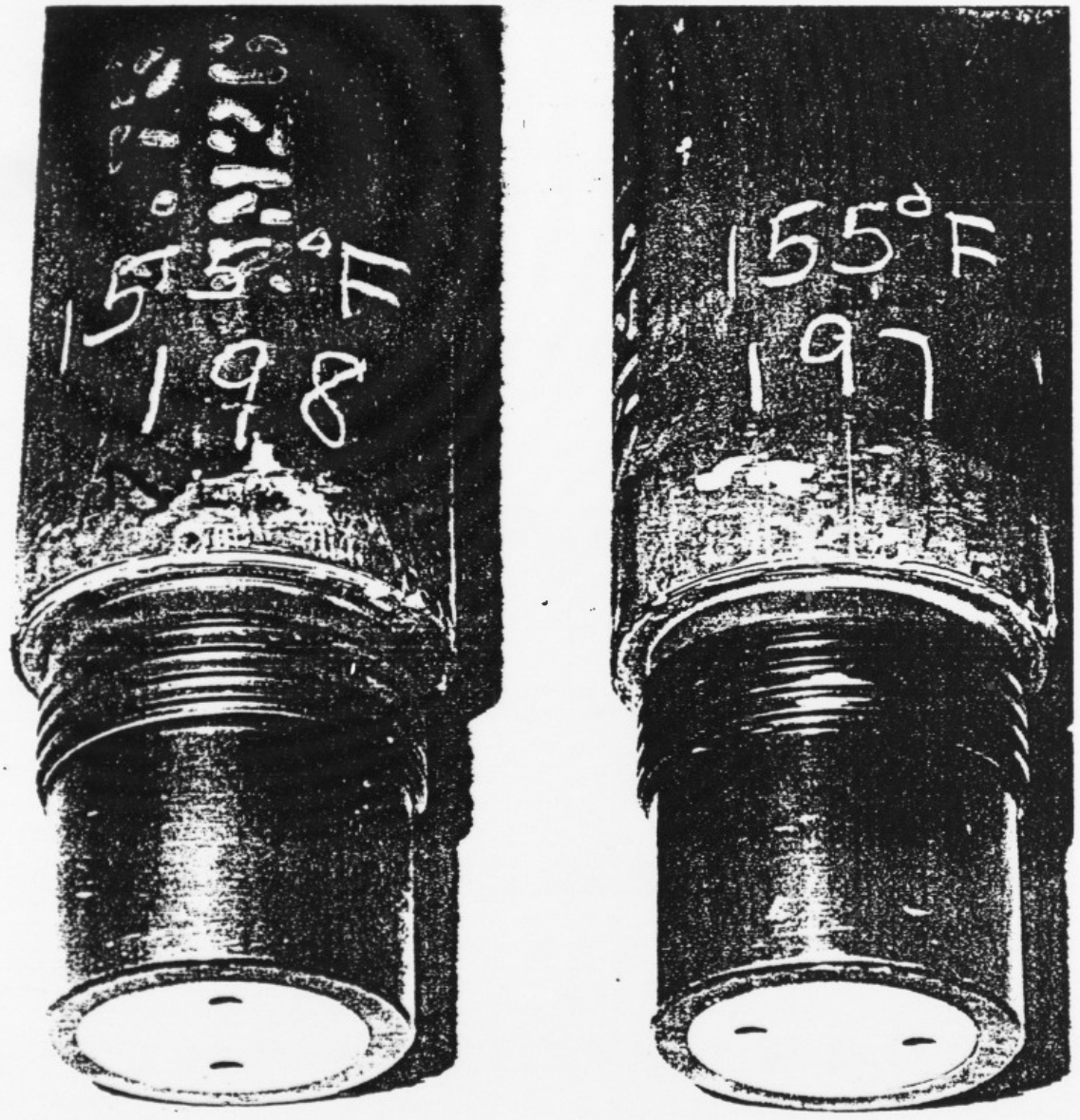

Figure 23. Box 2, 150°F, rd. no. 197 and 198. Warhead case pins or rivets sheared and/or elongated the pinholes in the warhead case assembly (PN 9334131) after the nose down and 45° to base down drops.

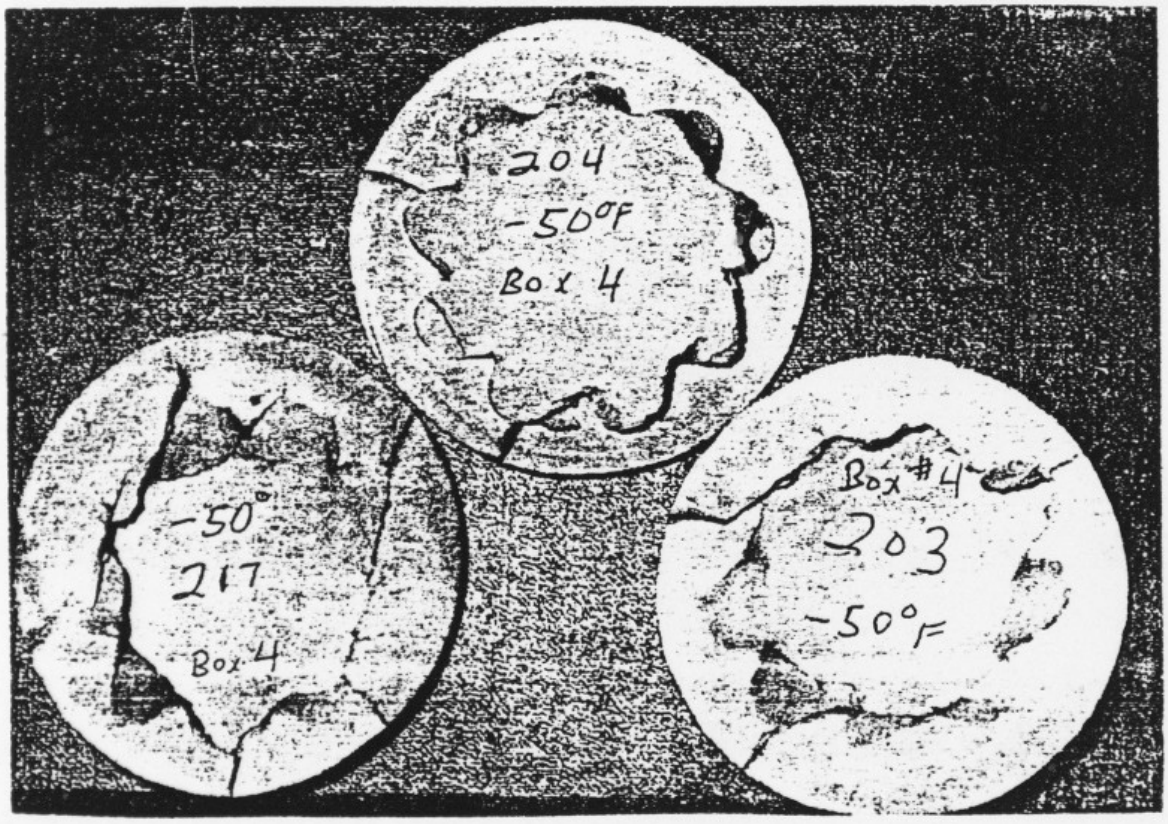

Figure 24. Box 4, -50°F, rd. No. 203, 204, 217. Fiber filler discs cut by rocket motor nozzle assembly.

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